Danish calculations of the NEACRP pin-power benchmark

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Abstract This report describes calculations performed for the NEACRP pin-power benchmark. The calculations are made with the code NEM2D, a diffusion theory code based on the nodal expansion method.

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1 Introduction

The benchmark is described in NEACRP-L-336. Six different »reactor« configurations are considered, each consisting of 4 PWR type assemblies and boundary conditions. 2-group cross sections for the smeared pin cells are given, which makes the benchmark essentially a test of the mathematical correctness of the codes. Items like mesh sizes and convergence criterias are left to the participants to decide upon, which together with a number of codes based on different principles (nodal expansion, mesh centres or mesh corners based difference techniques etc.) provides for quite a spread in results.

In the present report the Danish results to the benchmark are given. In addition some further studies of the quality of methods for pin-power reconstruction are presented.

2 The Benchmark

The benchmark is defined in (1). Here, for consistency, the main data are repeated:

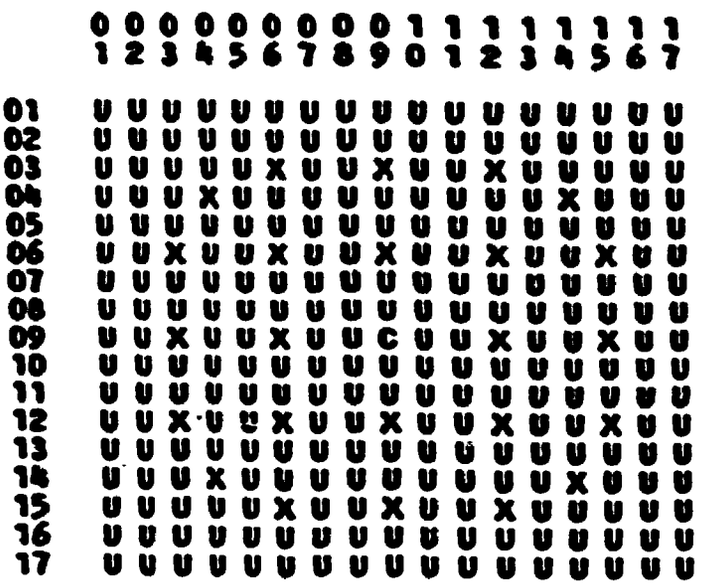
2.1 Assemblies

Three different PWR assemblies with 17 × 17 pin positions are considered. The assemblies are made up of a number of pin cells, for which smeared 2-group cross sections are supplied:

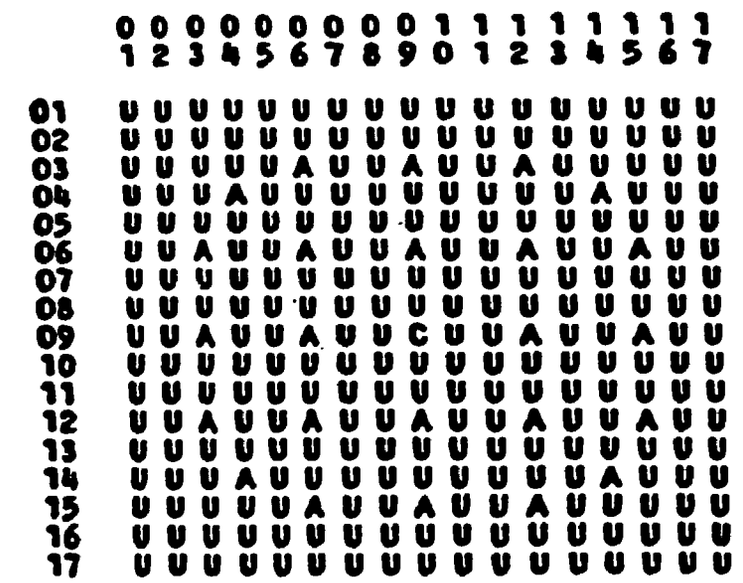
Cell type	D1 (cm)	SA1 (cm^{-1})	SR (cm^{-1})	NSF1 (cm^{-1})	D2 (cm)	SA2 (cm^{-1})	NSF2 (cm^{-1})
U : UO_2 Fuel	1.2	0.010	0.020	0.0050	0.4	0.100	0.125
P1 : Peripheral MOX Fuel	1.2	0.015	0.015	0.0075	0.4	0.200	0.300
P2 : Intermediate MOX Fuel	1.2	0.015	0.015	0.0075	0.4	0.250	0.375
P3 : Central MOX Fuel	1.2	0.015	0.015	0.0075	0.4	0.300	0.45
X : Guide Tube	1.2	0.001	0.025	0	0.4	0.02	0
R : Reflector	1.2	0.001	0.050	0	0.2	0.04	0
C : Moveable Fission Chamber	1.2	0.001	0.025	1.E-7	0.4	0.02	3.E-6
A : Absorber (AIC)	1.2	0.040	0.010	0	0.4	0.8	0

The three assembly types are composed from the above cell types as follows:

The »UX« assembly with 24 guide tubes and a central moveable fission chamber.



The »UA« assembly, where the 24 guide tubes are replaced by absorber pins (AIC)



The «PX» assembly which contains MOX pins with three different enrichments, 24 guide tubes and the fission chamber

```
      0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1
      1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7

01    P1P1P1P1P1P1P1P1P1P1P1P1P1P1P1P1P1
02    P1P2P2P2P2P2P2P2P2P2P2P2P2P2P2P1
03    P1P2P2P2P2X P2P2X P2P2X P2P2P2P2P1
04    P1P2P2X P2P3P3P3P3P3P3P3P2X P2P2P1
05    P1P2P2P2P3P3P3P3P3P3P3P3P3P2P2P2P1
06    P1P2X P3P3X P3P3X P3P3X P3P3X P2P1
07    P1P2P2P3P3P3P3P3P3P3P3P3P3P2P2P1
08    P1P2P2P3P3P3P3P3P3P3P3P3P3P2P2P1
09    P1P2X P3P3X P3P3C P3P3X P3P3X P2P1
10    P1P2P2P3P3P3P3P3P3P3P3P3P3P2P2P1
11    P1P2P2P3P3P3P3P3P3P3P3P3P3P2P2P1
12    P1P2X P3P3X P3P3X P3P3X P3P3X P2P1
13    P1P2P2P2P3P3P3P3P3P3P3P3P2P2P2P1
14    P1P2P2X P2P3P3P3P3P3P3P2X P2P2P1
15    P1P2P2P2P2X P2P2X P2P2X P2P2P2P2P1
16    P1P2P2P2P2P2P2P2P2P2P2P2P2P2P2P1
17    P1P1P1P1P1P1P1P1P1P1P1P1P1P1P1P1P1
```

2.2 »Reactor« Configurations

Six »reactor cores« are made of these assemblies:

Configuration	Geometrical description
C1 Uranium Infinite checker board	... UX UA UX UA ... ... UA UX UA UX ... ... UX UA UX UA ...
C2 Mox Infinite checker board	... UX PX UX PX ... ... PX UX PX UX ... ... UX PX UX PX ...
C3 Reflected Mox checker board	J = 0 / UX PX / PX UX / J = 0 (left, right, top, bottom) J = 0 represents reflective boundary conditions
C4 Semi reflected Mox checker board	J = 0 / UX PX / PX UX / PHI = 0 (left, right, top, bottom) PHI = 0 represents zero flux boundary conditions
C4V Semi reflected Mox checker board	J = 0 / UX PX / PX UX / VACUUM (left, right, top, bottom) Vacuum represents vacuum boundary condition
C5 Mox core configuration	J = 0 / UX PX R / PX UX R / R R R / PHI = 0 (left, right, top, bottom) R = Reflector

3 Calculations Performed

Flux and power distributions for the six configurations were calculated with the diffusion code NEM2D, a 2-dimensional version of the code described in (2) based on the nodal expansion method. One node per pin cell was used. The fluxes were normalized according to:

$$\sum_{i,j}(\nu_1 \Sigma_{f,1}\, \phi_1(i,j) + \nu_2 \Sigma_{f,2}\, \phi_2(i,j)) = k_{eff}$$

In addition to these »heterogeneous« calculations with one node per pin cell, calculations of a kind more simulating a practical approach were performed:

Calculations, where whole and quarter assemblies were isolated, supplied assembly smeared cross sections for »reactor« calculations with just 2 × 2 or 4 × 4 nodes, i.e. 1 node per assembly or 2 × 2 nodes per assembly. Methods for pin power reconstruction were then applied to obtain the detailed power distributions.

3.1 »Heterogeneous« Calculations

As smeared node cross sections were given, the calculations were straight-forward. The infinite checker-board configurations of cases 1 and 2, however, presented some difficulties, as none of our codes were prepared for this kind of boundary condition.

The nodal expansion code, NEM2D, was modified so as to cope with this boundary condition and then used, where a more obvious choice would otherwise have been a code based on difference equation techniques.

One node per pin cell was used. As the nodes usually employed in NEM codes are of assembly size (i.e. 100-300 pin cells), the mere possibility of using more than one node per pin was not even considered. (Results from other participants, who did try 2 × 2 nodes per pin cell, confirm that essentially nothing is gained by the subdivision of pin cells in nodal methods. It is quite another sake with difference equation techniques, where the results change substantially with 1 × 1, 2 × 2 or 4× 4 meshes per pin cell.)

3.2 Isolated Assembly Calculations

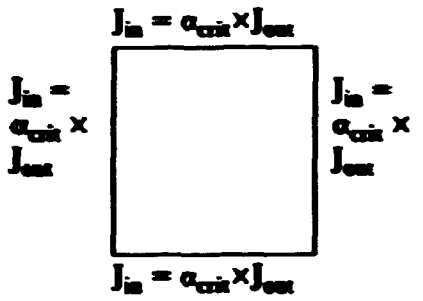
In a practical reactor core simulation, the first step will usually be a calculation of smeared cross sections and pin power distributions of the assemblies constituting the core.

In the present benchmark exercise, this was not the prime purpose, but nevertheless it was done, as the benchmark solutions constitute excellent test cases for the »practical« approaches.

With the NEM2D code calculations were performed on isolated assemblies and on isolated quarter assemblies.

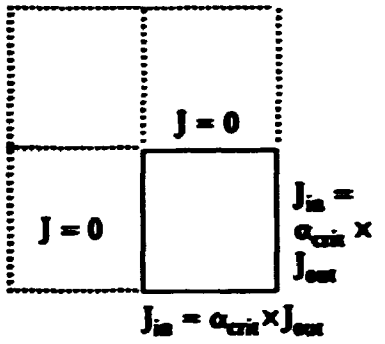
The boundary conditions employed were (in order to conform with the methods used in practical assembly calculations) albedoes, which make k_{eff} of the assembly equal to unity:

Whole Assembly Case



Same α_{crit} in both energy groups and on all four assembly sides.

Quarter Assembly Case



Same α_{crit} in both energy groups but only on the two (outer) sides.

Smeared 2-group cross sections are obtained from the calculations. They are corrected for the heterogeneity effect by dividing them by the »discontinuity factors« defined as the ratios of the edge fluxes obtained in the assembly calculation to the edge fluxes obtained in a calculation on the same geometry (and with the same albedoes), but with the smeared cross sections in all meshes.

Also, for subsequent use, the detailed pin powers of the assembly are produced. Again, instead of the pin powers directly obtained in the assembly calculation, the ratios of the *latter to the* »homogenized« pin powers are the ones to be used.

3.3 »Reactor« Calculations on Assembly Basis

With the smeared cross sections obtained from 3.2, calculations on the 6 »reactor« configurations were made. k_{eff}, assembly average powers, and, by the pin power reconstruction methods of 3.4, the detailed pin power distributions were calculated.

3.4 Pin Power Reconstruction

3.4.1 The Koebke-Wagner Method

The intra-node flux reconstruction method of Koebke and Wagner (3) has been implemented in the NEM2D code, although some uncertainty exists as to the treatment of nodes on the border of a reactor with a general albedo boundary condition.

This method is referred to as method 1.

3.4.2 The NEM-Method

In a nodal expansion method code, expansions for the intra-node flux distributions are determined as a part of the calculation.

Thus, free-of-charge, expansions of the form

$$\phi_{NEM}(x,y) = \sum_i P_i(x) \cdot \sum_j P_j(y)$$

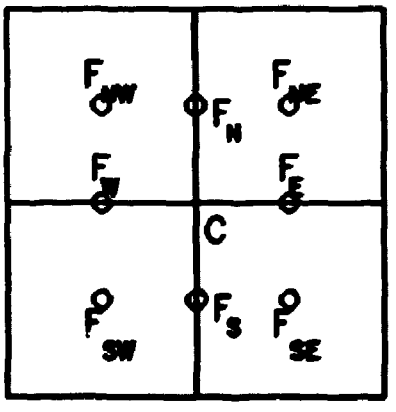
exist as a biproduct of the overall flux calculation.

Here $\phi_{NEM}(x,y)$ denotes the flux variation inside a node and the P's are polynomials of up to 4th degree. The flux is assumed separable in the coordinates, and thus may be suspected to be very inaccurate close to the corners of the nodes.

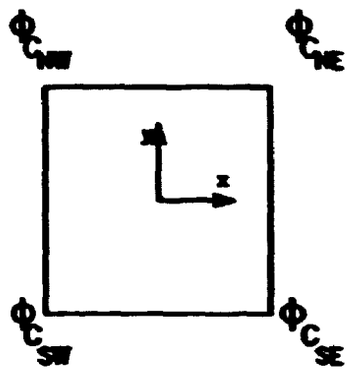
With a very small extra calculational effort four additional terms may be constructed to improve on the corner values. In (4) a method for determining the corner fluxes from the known NEM quantities is outlined:

$$\phi_c = ((D_{SW} + D_{NW}) \times F_W + (D_{NW} + D_{NE}) \times F_N + (D_{NE} + N_{SE}) \times F_E + (D_{SE} + D_{SW}) \times F_S$$
$$-(D_{NW} \times F_{NW} + D_{NE} \times F_{NE} + D_{SE} \times F_{SE} + D_{SW} \times F_{SW}))/(D_{NW} + D_{NE} + D_{SE} + D_{SW})$$

where the D's are diffusion coefficients and the F's are average edge or average node fluxes according to the figure below:



In this way the four corner fluxes of a node are determined



and used for the calculation of the four coefficients a_{55}, a_{56}, a_{65} and a_{66} to the 5th and 6th orders polynomials in x or y:

$$P_5(u) = u^5$$

$$P_6(u) = u^6 - 1/448$$

$$-0.5 \le u \le 0.5$$

The four equations are:

$$a_{55} \cdot P_5(x) \cdot P_5(y) + a_{56} \cdot P_5(x) \cdot P_6(y) + a_{65} \cdot P_6(x) \cdot P_5(y) + a_{66} \cdot P_6(x) \cdot P_6(y)\Big]_{\substack{x=-0.5 \\ y=0.5}}$$

$$= \phi_{C_{NW}} - \phi_{NEM}(x,y)\Big]_{\substack{x=-0.5 \\ y=0.5}}$$

and similarly for the three other corners.

The resulting flux approximation in a node is then

$$\phi(x,y) = \phi_{NEM}(x,y) + \sum_{i,j=5,6} a_{ij} P_i(x) \cdot P_j(y)$$

This method is referred to as method 2.

4 Results

The results of the calculations are given below.

For each of the six benchmark cases the results are listed with the following layout:

1) k_{eff} (1 node/pin cell)
   k_{eff} (1 node/assembly)
   k_{eff} (4 nodes/assembly)

2) Assembly powers, normalized to k_{eff} (1 node/pin cell) in tables of 2 × 2 members. Each member gives

   Assembly power with 1 node/pin
   Assembly power with 1 node/assembly
   Assembly power with 4 nodes/assembly

3) 17 × 17 tables of detailed power distributions. Each member of the table gives:

   10^6 × pin cell power from 1 node/pin calculation
   Relative error (%), Pin power reconstruction, method 1
   Relative error (%), Pin power reconstruction, method 2

The errors are calculated as:

$$\text{Error} = 100 \cdot \frac{P_{PPR} - P_{17\times17}}{P_{17\times17}} \ \%$$

where P_{PPR} is the power found in the pin-power reconstruction and $P_{17\times17}$ is the power from the 17×17 nodes/assembly calculation. At the bottom of the tables, the assembly powers, average and maximum errors are given, as well for the 2×2 nodes/assembly reconstructions as for the 1 node/assembly reconstructions.

In the figures 4.1.1 through 4.5.3, diagonal traverses of the power distributions of the assemblies are shown. The »reference« 17×17 nodes/assembly distributions are given as bars, and the 1 node/assembly and 2×2 nodes/assembly values of both methods are shown by marks.

4.1 C1:UX/UA Configuration in an Infinite Checkerboard Pattern

k_{eff} (1 node/pin) = 0.83736
k_{eff} (1 node/assembly) = 0.83636
k_{eff} (4 nodes/assembly) = 0.83684

Assembly Powers:

UX 0.25346 0.24367 0.24439	**UA** 0.16496 0.17427 0.17376
UA 0.16496 0.17427 0.17376	**UX** 0.25346 0.24367 0.24439

Table 4.1.1
C1, UX assembly.

864	867	865	862	858	855	852	850	850	850	852	855	858	862	865	867	864
-11.1	-9.6	-7.6	-5.8	-4.2	-2.9	-2.3	-2.1	-2.3	-2.1	-2.3	-2.9	-4.2	-5.8	-7.6	-9.6	-11.1
-13.6	-11.4	-8.4	-5.8	-3.6	-2.0	-0.9	-0.4	-0.8	-0.4	-0.9	-2.0	-3.6	-5.8	-8.4	-11.4	-13.6
867	884	898	911	924	935	925	925	934	925	925	935	924	911	898	884	867
-9.6	-7.4	-5.7	-4.6	-3.5	-2.7	-2.0	-1.7	-2.1	-1.7	-2.0	-2.7	-3.5	-4.6	-5.7	-7.4	-9.6
-11.4	-8.2	-6.0	-4.5	-3.3	-2.3	-1.2	-0.6	-0.4	-0.6	-1.2	-2.3	-3.3	-4.5	-6.0	-8.2	-11.4
865	898	933	967	986	0	985	985	0	985	985	0	986	967	933	898	865
-7.6	-5.7	-4.8	-4.3	-3.6	0.0	-2.1	-1.5	0.0	-1.5	-2.1	0.0	-3.6	-4.3	-4.8	-5.7	-7.6
-8.4	-6.0	-4.8	-4.1	-3.4	0.0	-2.0	-1.4	0.0	-1.4	-2.0	0.0	-3.4	-4.1	-4.8	-6.0	-8.4
862	911	967	0	1018	1018	1007	1008	1019	1008	1007	1018	1018	0	967	911	862
-5.8	-4.6	-4.3	0.0	-3.9	-3.2	-2.4	-1.6	-1.1	-1.6	-2.4	-3.2	-3.9	0.0	-4.3	-4.6	-5.8
-5.8	-4.5	-4.1	0.0	-3.5	-3.1	-2.6	-2.1	-1.8	-2.1	-2.6	-3.1	-3.5	0.0	-4.1	-4.5	-5.8
858	924	986	1018	1027	1038	1030	1032	1044	1032	1030	1038	1027	1018	986	924	858
-4.2	-3.5	-3.6	-3.9	-4.0	-3.7	-3.0	-2.1	-1.5	-2.1	-3.0	-3.7	-4.0	-3.9	-3.6	-3.5	-4.2
-3.6	-3.3	-3.4	-3.5	-3.6	-3.6	-3.3	-2.9	-2.7	-2.9	-3.3	-3.6	-3.6	-3.5	-3.4	-3.3	-3.6
855	935	0	1018	1038	0	1055	1059	0	1059	1055	0	1038	1018	0	935	855
-2.9	-2.7	0.0	-3.2	-3.7	0.0	-3.3	-2.6	0.0	-2.6	-3.3	0.0	-3.7	-3.2	0.0	-2.7	-2.9
-2.0	-2.3	0.0	-3.1	-3.6	0.0	-3.7	-3.4	0.0	-3.4	-3.7	0.0	-3.6	-3.1	0.0	-2.3	-2.0
852	925	985	1007	1030	1055	1053	1058	1070	1058	1053	1055	1030	1007	985	925	852
-2.3	-2.0	-2.1	-2.4	-3.0	-3.3	-3.2	-2.9	-2.5	-2.9	-3.2	-3.3	-3.0	-2.4	-2.1	-2.0	-2.3
-0.9	-1.2	-2.0	-2.6	-3.3	-3.7	-3.7	-3.4	-3.1	-3.4	-3.7	-3.7	-3.3	-2.6	-2.0	-1.2	-0.9
850	925	985	1008	1032	1059	1058	1063	1077	1063	1058	1059	1032	1008	985	925	850
-2.1	-1.7	-1.5	-1.6	-2.1	-2.6	-2.9	-3.0	-3.2	-3.0	-2.9	-2.6	-2.1	-1.6	-1.5	-1.7	-2.1
-0.4	-0.6	-1.4	-2.1	-2.9	-3.4	-3.4	-3.1	-3.2	-3.1	-3.4	-3.4	-2.9	-2.1	-1.4	-0.6	-0.4
850	934	0	1019	1044	0	1070	1077	0	1077	1070	0	1044	1019	0	934	850
-2.3	-2.1	0.0	-1.1	-1.5	0.0	-2.5	-3.2	0.0	-3.2	-2.5	0.0	-1.5	-1.1	0.0	-2.1	-2.3
-0.8	-0.4	0.0	-1.8	-2.7	0.0	-3.1	-3.2	0.0	-3.2	-3.1	0.0	-2.7	-1.8	0.0	-0.4	-0.8
850	925	985	1008	1032	1059	1058	1063	1077	1063	1058	1059	1032	1008	985	925	850
-2.1	-1.7	-1.5	-1.6	-2.1	-2.6	-2.9	-3.0	-3.2	-3.0	-2.9	-2.6	-2.1	-1.6	-1.5	-1.7	-2.1
-0.4	-0.6	-1.4	-2.1	-2.9	-3.4	-3.4	-3.1	-3.2	-3.1	-3.4	-3.4	-2.9	-2.1	-1.4	-0.6	-0.4
852	925	985	1007	1030	1055	1053	1058	1070	1058	1053	1055	1030	1007	985	925	852
-2.3	-2.0	-2.1	-2.4	-3.0	-3.3	-3.2	-2.9	-2.5	-2.9	-3.2	-3.3	-3.0	-2.4	-2.1	-2.0	-2.3
-0.9	-1.2	-2.0	-2.6	-3.3	-3.7	-3.7	-3.4	-3.1	-3.4	-3.7	-3.7	-3.3	-2.6	-2.0	-1.2	-0.9
855	935	0	1018	1038	0	1055	1059	0	1059	1055	0	1038	1018	0	935	855
-2.9	-2.7	0.0	-3.2	-3.7	0.0	-3.3	-2.6	0.0	-2.6	-3.3	0.0	-3.7	-3.2	0.0	-2.7	-2.9
-2.0	-2.3	0.0	-3.1	-3.6	0.0	-3.7	-3.4	0.0	-3.4	-3.7	0.0	-3.6	-3.1	0.0	-2.3	-2.0
858	924	986	1018	1027	1038	1030	1032	1044	1032	1030	1038	1027	1018	986	924	858
-4.2	-3.5	-3.6	-3.9	-4.0	-3.7	-3.0	-2.1	-1.5	-2.1	-3.0	-3.7	-4.0	-3.9	-3.6	-3.5	-4.2
-3.6	-3.3	-3.4	-3.5	-3.6	-3.6	-3.3	-2.9	-2.7	-2.9	-3.3	-3.6	-3.6	-3.5	-3.4	-3.3	-3.6
862	911	967	0	1018	1018	1007	1008	1019	1008	1007	1018	1018	0	967	911	862
-5.8	-4.6	-4.3	0.0	-3.9	-3.2	-2.4	-1.6	-1.1	-1.6	-2.4	-3.2	-3.9	0.0	-4.3	-4.6	-5.8
-5.8	-4.5	-4.1	0.0	-3.5	-3.1	-2.6	-2.1	-1.8	-2.1	-2.6	-3.1	-3.5	0.0	-4.1	-4.5	-5.8
865	898	933	967	986	0	985	985	0	985	985	0	986	967	933	898	865
-7.6	-5.7	-4.8	-4.3	-3.6	0.0	-2.1	-1.5	0.0	-1.5	-2.1	0.0	-3.6	-4.3	-4.8	-5.7	-7.6
-8.4	-6.0	-4.8	-4.1	-3.4	0.0	-2.0	-1.4	0.0	-1.4	-2.0	0.0	-3.4	-4.1	-4.8	-6.0	-8.4
867	884	898	911	924	935	925	925	934	925	925	935	924	911	898	884	867
-9.6	-7.4	-5.7	-4.6	-3.5	-2.7	-2.0	-1.7	-2.1	-1.7	-2.0	-2.7	-3.5	-4.6	-5.7	-7.4	-9.6
-11.4	-8.2	-6.0	-4.5	-3.3	-2.3	-1.2	-0.6	-0.4	-0.6	-1.2	-2.3	-3.3	-4.5	-6.0	-8.2	-11.4
864	867	865	862	858	855	852	850	850	850	852	855	858	862	865	867	864
-11.1	-9.6	-7.6	-5.8	-4.2	-2.9	-2.3	-2.1	-2.3	-2.1	-2.3	-2.9	-4.2	-5.8	-7.6	-9.6	-11.1
-13.6	-11.4	-8.4	-5.8	-3.6	-2.0	-0.9	-0.4	-0.8	-0.4	-0.9	-2.0	-3.6	-5.8	-8.4	-11.4	-13.6

Assembly power (het.) : 0.25346

Assembly power (1 n/ass.) : 0.24367

Assembly power (4 n/ass.) : 0.24439

Errors (1 n/ass.) Method 1: Av. 3.9% Max.-10.9% Method 2: Av. 3.9% Max.-11.5%

Errors (4 n/ass.) Method 1: Av. 3.6% Max.-11.1% Method 2: Av. 3.6% Max.-13.6%

Table 4.1.2
C1, UA assembly.

857	844	826	804	783	768	765	763	760	763	765	768	783	804	826	844	857
24.3	20.5	16.8	13.1	9.4	6.7	5.1	4.3	4.2	4.3	5.1	6.7	9.4	13.1	16.8	20.5	24.3
32.2	26.1	18.9	13.0	8.0	4.2	1.8	0.5	1.3	0.5	1.8	4.2	8.0	13.0	18.9	26.1	32.2
844	812	771	725	673	626	651	649	619	649	651	626	673	725	771	812	844
20.5	14.9	11.2	8.5	6.2	4.2	2.7	1.9	2.1	1.9	2.7	4.2	6.2	8.5	11.2	14.9	20.5
26.1	17.4	11.8	8.2	5.4	3.2	1.1	-0.3	-0.8	-0.3	1.1	3.2	5.4	8.2	11.8	17.4	26.1
826	771	688	596	541	0	545	545	0	545	545	0	541	596	688	771	826
16.8	11.2	8.3	6.4	4.6	0.0	1.8	0.8	0.0	0.8	1.8	0.0	4.6	6.4	8.3	11.2	16.8
18.9	11.8	8.2	5.9	4.2	0.0	1.4	0.5	0.0	0.5	1.4	0.0	4.2	5.9	8.2	11.8	18.9
804	725	596	0	485	494	533	534	504	534	533	494	485	0	596	725	804
13.1	8.5	6.4	0.0	3.8	2.9	1.8	0.5	-0.3	0.5	1.8	2.9	3.8	0.0	6.4	8.5	13.1
13.0	8.2	5.9	0.0	3.4	2.7	1.9	1.3	0.6	1.3	1.9	2.7	3.4	0.0	5.9	8.2	13.0
783	673	541	485	489	479	514	516	488	516	514	479	489	485	541	673	783
9.4	6.2	4.6	3.8	3.8	3.4	2.2	0.8	0.0	0.8	2.2	3.4	3.8	3.8	4.6	6.2	9.4
8.0	5.4	4.2	3.4	3.4	3.4	2.9	2.1	1.6	2.1	2.9	3.4	3.4	3.4	4.2	5.4	8.0
768	626	0	494	479	0	481	484	0	484	481	0	479	494	0	626	768
6.7	4.2	0.0	2.9	3.4	0.0	2.4	1.3	0.0	1.3	2.4	0.0	3.4	2.9	0.0	4.2	6.7
4.2	3.2	0.0	2.7	3.4	0.0	3.0	2.6	0.0	2.6	3.0	0.0	3.4	2.7	0.0	3.2	4.2
765	651	545	533	514	481	514	527	507	527	514	481	514	533	545	651	765
5.1	2.7	1.8	1.8	2.2	2.4	2.1	1.4	0.8	1.4	2.1	2.4	2.2	1.8	1.8	2.7	5.1
1.8	1.1	1.4	1.9	2.9	3.0	3.0	2.6	1.8	2.6	3.0	3.0	2.9	1.9	1.4	1.1	1.8
763	649	545	534	516	484	527	571	587	571	527	484	516	534	545	649	763
4.3	1.9	0.8	0.5	0.8	1.3	1.4	1.4	1.4	1.4	1.4	1.3	0.8	0.5	0.8	1.9	4.3
0.5	-0.3	0.5	1.3	2.1	2.6	2.6	2.1	1.4	2.1	2.6	2.6	2.1	1.3	0.5	-0.3	0.5
760	619	0	504	488	0	507	587	0	587	507	0	488	504	0	619	760
4.2	2.1	0.0	-0.3	0.0	0.0	0.8	1.4	0.0	1.4	0.8	0.0	0.0	-0.3	0.0	2.1	4.2
1.3	-0.8	0.0	0.6	1.6	0.0	1.8	1.4	0.0	1.4	1.8	0.0	1.6	0.6	0.0	-0.8	1.3
763	649	545	534	516	484	527	571	587	571	527	484	516	534	545	649	763
4.3	1.9	0.8	0.5	0.8	1.3	1.4	1.4	1.4	1.4	1.4	1.3	0.8	0.5	0.8	1.9	4.3
0.5	-0.3	0.5	1.3	2.1	2.6	2.6	2.1	1.4	2.1	2.6	2.6	2.1	1.3	0.5	-0.3	0.5
765	651	545	533	514	481	514	527	507	527	514	481	514	533	545	651	765
5.1	2.7	1.8	1.8	2.2	2.4	2.1	1.4	0.8	1.4	2.1	2.4	2.2	1.8	1.8	2.7	5.1
1.8	1.1	1.4	1.9	2.9	3.0	3.0	2.6	1.8	2.6	3.0	3.0	2.9	1.9	1.4	1.1	1.8
768	626	0	494	479	0	481	484	0	484	481	0	479	494	0	626	768
6.7	4.2	0.0	2.9	3.4	0.0	2.4	1.3	0.0	1.3	2.4	0.0	3.4	2.9	0.0	4.2	6.7
4.2	3.2	0.0	2.7	3.4	0.0	3.0	2.6	0.0	2.6	3.0	0.0	3.4	2.7	0.0	3.2	4.2
783	673	541	485	489	479	514	516	488	516	514	479	489	485	541	673	783
9.4	6.2	4.6	3.8	3.8	3.4	2.2	0.8	0.0	0.8	2.2	3.4	3.8	3.8	4.6	6.2	9.4
8.0	5.4	4.2	3.4	3.4	3.4	2.9	2.1	1.6	2.1	2.9	3.4	3.4	3.4	4.2	5.4	8.0
804	725	596	0	485	494	533	534	504	534	533	494	485	0	596	725	804
13.1	8.5	6.4	0.0	3.8	2.9	1.8	0.5	-0.3	0.5	1.8	2.9	3.8	0.0	6.4	8.5	13.1
13.0	8.2	5.9	0.0	3.4	2.7	1.9	1.3	0.6	1.3	1.9	2.7	3.4	0.0	5.9	8.2	13.0
826	771	688	596	541	0	545	545	0	545	545	0	541	596	688	771	826
16.8	11.2	8.3	6.4	4.6	0.0	1.8	0.8	0.0	0.8	1.8	0.0	4.6	6.4	8.3	11.2	16.8
18.9	11.8	8.2	5.9	4.2	0.0	1.4	0.5	0.0	0.5	1.4	0.0	4.2	5.9	8.2	11.8	18.9
844	812	771	725	673	626	651	649	619	649	651	626	673	725	771	812	844
20.5	14.9	11.2	8.5	6.2	4.2	2.7	1.9	2.1	1.9	2.7	4.2	6.2	8.5	11.2	14.9	20.5
26.1	17.4	11.8	8.2	5.4	3.2	1.1	-0.3	-0.8	-0.3	1.1	3.2	5.4	8.2	11.8	17.4	26.1
857	844	826	804	783	768	765	763	760	763	765	768	783	804	826	844	857
24.3	20.5	16.8	13.1	9.4	6.7	5.1	4.3	4.2	4.3	5.1	6.7	9.4	13.1	16.8	20.5	24.3
32.2	26.1	18.9	13.0	8.0	4.2	1.8	0.5	1.3	0.5	1.8	4.2	8.0	13.0	18.9	26.1	32.2

Assembly power (het.) : 0.16496

Assembly power (1 n/ass.) : 0.17427

Assembly power (4 n/ass.) : 0.17376

Errors (1 n/ass.) Method 1: Av. 5.6% Max. 25.4% Method 2: Av. 5.6% Max. 27.2%

Errors (4 n/ass.) Method 1: Av. 5.4% Max. 24.3% Method 2: Av. 5.4% Max. 32.2%

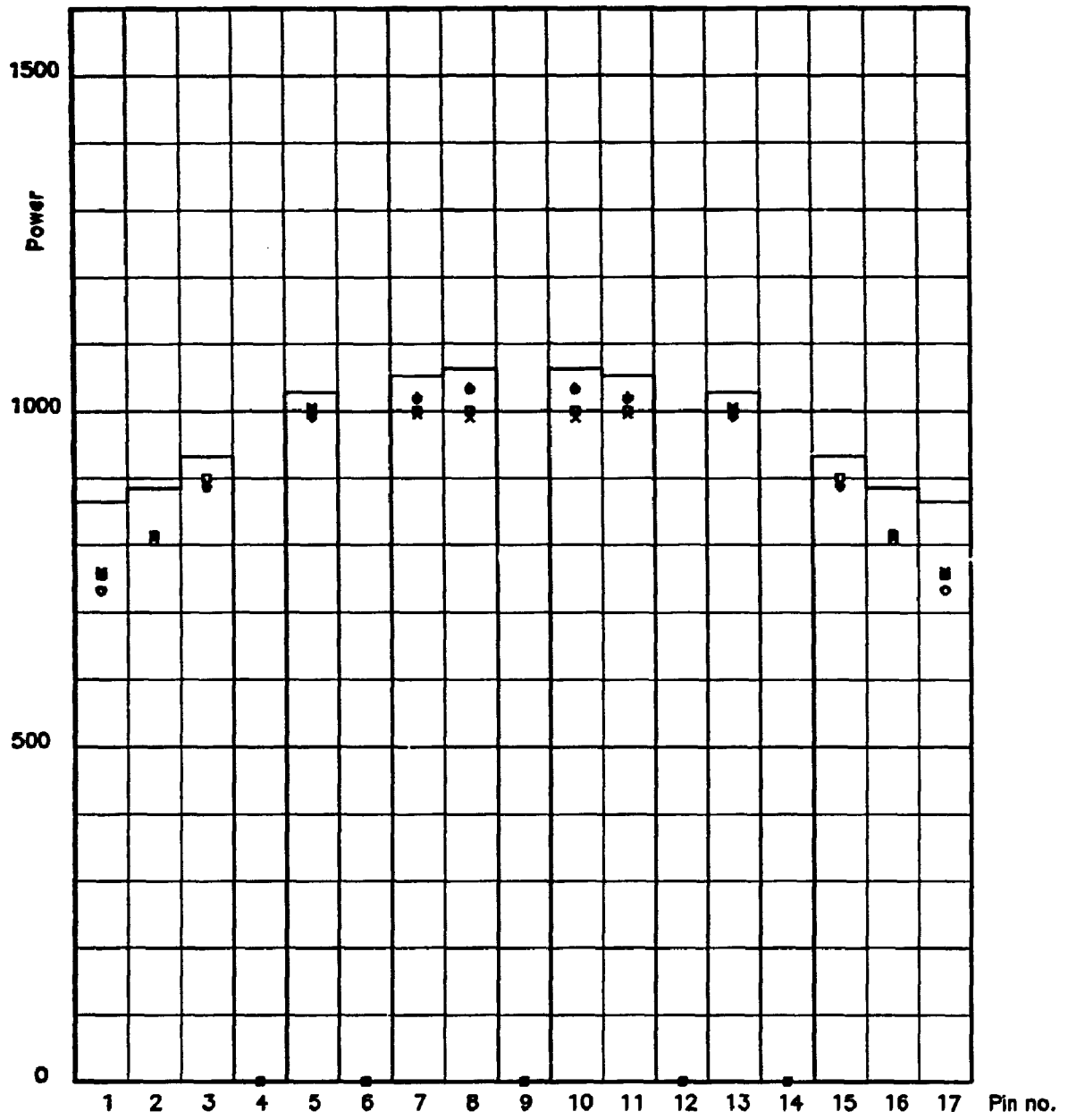


Figure 4.1.1

C1, UX assembly

Diagonal power traverse

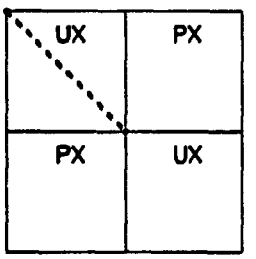
——— 'Heterogeneous' calc.

× Method 1, 1 node /ass.

+ Method 1, 4 nodes/ass.

□ Method 2, 1 node /ass.

○ Method 2, 4 nodes/ass.



Boundary: Infinite checkerboard

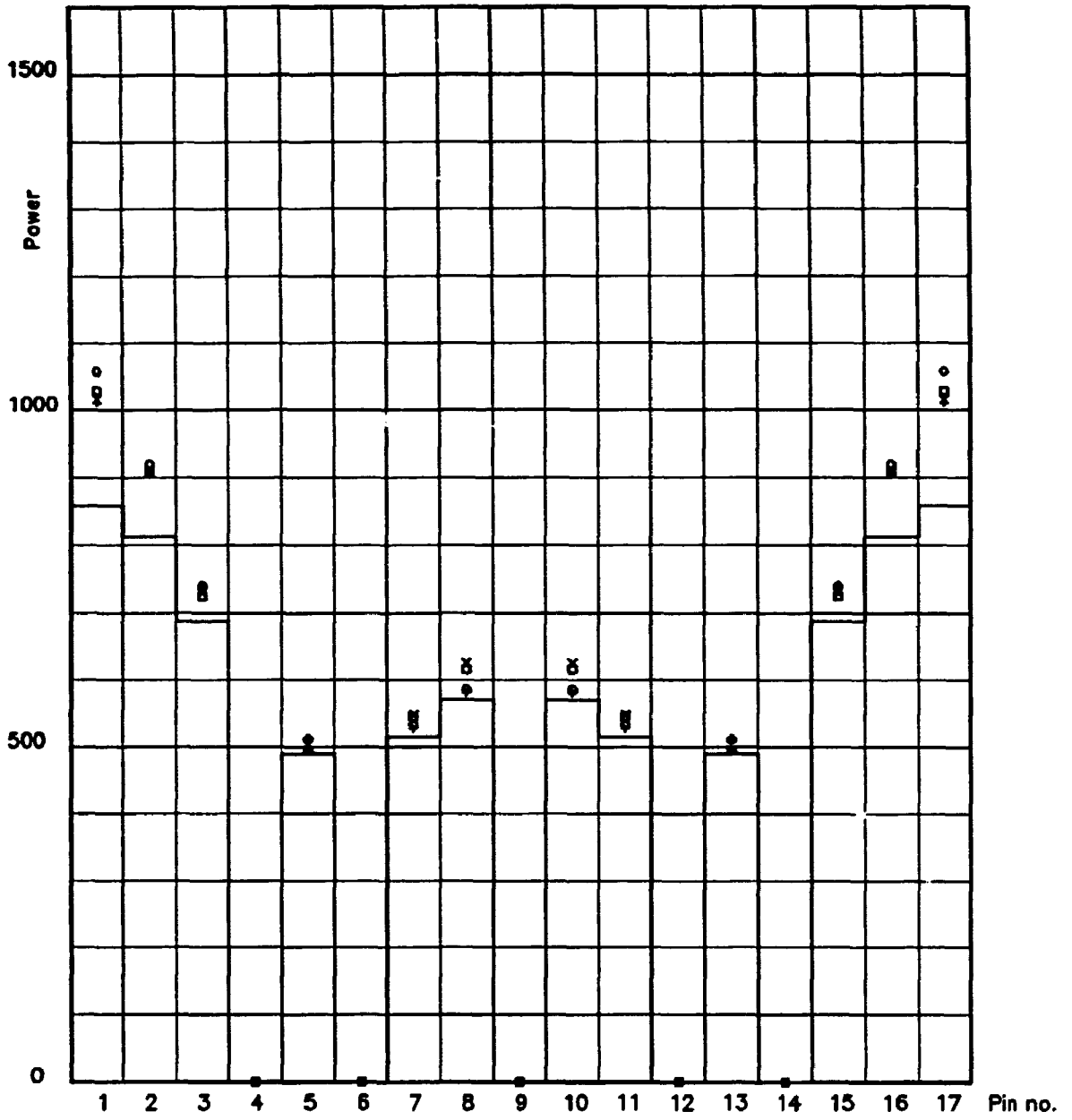
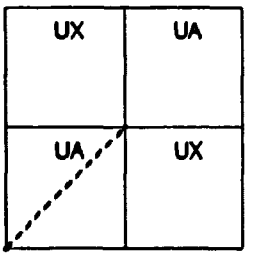


Figure 4.1.2

C1, UA assembly

Diagonal power traverse

- ——— *'Heterogeneous' calc.*
- × Method 1, 1 node /ass.
- + Method 1, 4 nodes/ass.
- □ Method 2, 1 node /ass.
- ○ Method 2, 4 nodes/ass.



Boundary: Infinite checkerboard

1.2 C2: UX/PX Configuration in an Infinite Checkerboard Pattern

k_{eff} (1 node/pin) = 1.02426
k_{eff} (1 node/assembly) = 1.02455
k_{eff} (4 nodes/assembly) = 1.02526

Assembly Powers:

UX	PX
0.21466	0.29720
0.21507	0.29694
0.21343	0.29891
PX	**UX**
0.29720	0.21466
0.29694	0.21507
0.29891	0.21343

Table 4.2.1
C2, UX assembly.

617	647	662	673	681	686	687	687	688	687	687	686	681	673	662	647	617
-3.7	-2.7	-1.1	0.1	0.9	1.1	1.0	0.5	-0.5	0.5	1.0	1.1	0.9	0.1	-1.1	-2.7	-3.7
-4.3	-1.8	0.0	0.5	0.1	0.0	0.2	0.7	0.7	0.7	0.2	0.0	0.1	0.5	0.0	-1.8	-4.3
647	714	749	772	789	803	796	796	804	796	796	803	789	772	749	714	647
-2.7	-1.4	0.4	1.2	1.6	1.7	1.8	1.5	0.2	1.5	1.8	1.7	1.6	1.2	0.4	-1.4	-2.7
-1.8	0.2	1.4	1.1	0.5	0.1	0.5	1.4	2.0	1.4	0.5	0.1	0.5	1.1	1.4	0.2	-1.8
662	749	804	842	862	0	862	862	0	862	862	0	862	842	804	749	662
-1.1	0.4	1.1	1.1	0.7	0.0	1.0	1.4	0.0	1.4	1.0	0.0	0.7	1.1	1.1	0.4	-1.1
0.0	1.4	1.6	1.0	0.1	0.0	0.0	0.9	0.0	0.9	0.0	0.0	0.1	1.0	1.6	1.4	0.0
673	772	842	0	895	894	883	882	891	882	883	894	895	0	842	772	673
0.1	1.2	1.1	0.0	-1.4	-1.8	-1.2	0.1	0.9	0.1	-1.2	-1.8	-1.4	0.0	1.1	1.2	0.1
0.5	1.1	1.0	0.0	-1.1	-1.6	-1.4	-0.4	0.4	-0.4	-1.4	-1.6	-1.1	0.0	1.0	1.1	0.5
681	789	862	895	901	908	897	897	906	897	897	908	901	895	862	789	681
0.9	1.6	0.7	-1.4	-3.3	-4.2	-3.4	-1.6	0.0	-1.6	-3.4	-4.2	-3.3	-1.4	0.7	1.6	0.9
0.1	0.5	0.1	-1.1	-2.3	-3.1	-2.7	-1.8	-1.2	-1.8	-2.7	-3.1	-2.3	-1.1	0.1	0.5	0.1
686	803	0	894	908	0	913	913	0	913	913	0	908	894	0	803	686
1.1	1.7	0.0	-1.8	-4.2	0.0	-4.7	-2.6	0.0	-2.6	-4.7	0.0	-4.2	-1.8	0.0	1.7	1.1
0.0	0.1	0.0	-1.6	-3.1	0.0	-3.6	-2.6	0.0	-2.6	-3.6	0.0	-3.1	-1.6	0.0	0.1	0.0
687	796	862	883	897	913	906	907	917	907	906	913	897	883	862	796	687
1.0	1.8	1.0	-1.2	-3.4	-4.7	-4.3	-2.7	-1.1	-2.7	-4.3	-4.7	-3.4	-1.2	1.0	1.8	1.0
0.2	0.5	0.0	-1.4	-2.7	-3.6	-3.2	-2.3	-1.8	-2.3	-3.2	-3.6	-2.7	-1.4	0.0	0.5	0.2
687	796	862	882	897	913	907	908	918	908	907	913	897	882	862	796	687
0.5	1.5	1.4	0.1	-1.6	-2.6	-2.7	-1.8	-1.0	-1.8	-2.7	-2.6	-1.6	0.1	1.4	1.5	0.5
0.7	1.4	0.9	-0.4	-1.8	-2.6	-2.3	-1.4	-1.0	-1.4	-2.3	-2.6	-1.8	-0.4	0.9	1.4	0.7
688	804	0	891	906	0	917	918	0	918	917	0	906	891	0	804	688
-0.5	0.2	0.0	0.9	0.0	0.0	-1.1	-1.0	0.0	-1.0	-1.1	0.0	0.0	0.9	0.0	0.2	-0.5
0.7	2.0	0.0	0.4	-1.2	0.0	-1.8	-1.0	0.0	-1.0	-1.8	0.0	-1.2	0.4	0.0	2.0	0.7
687	796	862	882	897	913	907	908	918	908	907	913	897	882	862	796	687
0.5	1.5	1.4	0.1	-1.6	-2.6	-2.7	-1.8	-1.0	-1.8	-2.7	-2.6	-1.6	0.1	1.4	1.5	0.5
0.7	1.4	0.9	-0.4	-1.8	-2.6	-2.3	-1.4	-1.0	-1.4	-2.3	-2.6	-1.8	-0.4	0.9	1.4	0.7
687	796	862	883	897	913	906	907	917	907	906	913	897	883	862	796	687
1.0	1.8	1.0	-1.2	-3.4	-4.7	-4.3	-2.7	-1.1	-2.7	-4.3	-4.7	-3.4	-1.2	1.0	1.8	1.0
0.2	0.5	0.0	-1.4	-2.7	-3.6	-3.2	-2.3	-1.8	-2.3	-3.2	-3.6	-2.7	-1.4	0.0	0.5	0.2
686	803	0	894	908	0	913	913	0	913	913	0	908	894	0	803	686
1.1	1.7	0.0	-1.8	-4.2	0.0	-4.7	-2.6	0.0	-2.6	-4.7	0.0	-4.2	-1.8	0.0	1.7	1.1
0.0	0.1	0.0	-1.6	-3.1	0.0	-3.6	-2.6	0.0	-2.6	-3.6	0.0	-3.1	-1.6	0.0	0.1	0.0
681	789	862	895	901	908	897	897	906	897	897	908	901	895	862	789	681
0.9	1.6	0.7	-1.4	-3.3	-4.2	-3.4	-1.6	0.0	-1.6	-3.4	-4.2	-3.3	-1.4	0.7	1.6	0.9
0.1	0.5	0.1	-1.1	-2.3	-3.1	-2.7	-1.8	-1.2	-1.8	-2.7	-3.1	-2.3	-1.1	0.1	0.5	0.1
673	772	842	0	895	894	883	882	891	882	883	894	895	0	842	772	673
0.1	1.2	1.1	0.0	-1.4	-1.8	-1.2	0.1	0.9	0.1	-1.2	-1.8	-1.4	0.0	1.1	1.2	0.1
0.5	1.1	1.0	0.0	-1.1	-1.6	-1.4	-0.4	0.4	-0.4	-1.4	-1.6	-1.1	0.0	1.0	1.1	0.5
662	749	804	842	862	0	862	862	0	862	862	0	862	842	804	749	662
-1.1	0.4	1.1	1.1	0.7	0.0	1.0	1.4	0.0	1.4	1.0	0.0	0.7	1.1	1.1	0.4	-1.1
0.0	1.4	1.6	1.0	0.1	0.0	0.0	0.9	0.0	0.9	0.0	0.0	0.1	1.0	1.6	1.4	0.0
647	714	749	772	789	803	796	796	804	796	796	803	789	772	749	714	647
-2.7	-1.4	0.4	1.2	1.6	1.7	1.8	1.5	0.2	1.5	1.8	1.7	1.6	1.2	0.4	-1.4	-2.7
-1.8	0.2	1.4	1.1	0.5	0.1	0.5	1.4	2.0	1.4	0.5	0.1	0.5	1.1	1.4	0.2	-1.8
617	647	662	673	681	686	687	687	688	687	687	686	681	673	662	647	617
-3.7	-2.7	-1.1	0.1	0.9	1.1	1.0	0.5	-0.5	0.5	1.0	1.1	0.9	0.1	-1.1	-2.7	-3.7
-4.3	-1.8	0.0	0.5	0.1	0.0	0.2	0.7	0.7	0.7	0.2	0.0	0.1	0.5	0.0	-1.8	-4.3

Assembly power (het.) : 0.21464

Assembly power (1 n/ass.) : 0.21507

Assembly power (4 n/ass.) : 0.21343

Errors (1 n/ass.) Method 1: Av. 4.0% Max.-16.4% Method 2: Av. 3.0% Max. -9.2%

Errors (4 n/ass.) Method 1: Av. 1.6% Max. -4.7% Method 2: Av. 1.2% Max. -4.3%

Table 4.2.2
C2, PX assembly.

1228	1164	1151	1156	1166	1174	1173	1173	1175	1173	1173	1174	1166	1156	1151	1164	1224
4.5	2.5	1.2	1.2	1.9	2.1	2.0	2.0	3.3	2.0	2.0	2.1	1.9	1.2	1.2	2.5	4.5
9.2	2.0	-1.9	-0.5	2.7	4.3	2.9	0.5	-0.1	0.5	2.9	4.3	2.7	-0.5	-1.9	2.0	9.2
1164	1206	1148	1145	1168	1199	1164	1161	1192	1161	1164	1199	1168	1145	1148	1206	1164
2.5	-3.0	-5.5	-5.5	-4.5	-3.9	-4.6	-5.2	-3.2	-5.2	-4.6	-3.9	-4.5	-5.5	-5.5	-3.0	2.5
2.0	-6.3	-7.9	-5.5	-2.1	-0.4	-2.0	-5.2	-7.5	-5.2	-2.0	-0.4	-2.1	-5.5	-7.9	-6.3	2.0
1151	1148	1091	1113	1124	0	1076	1070	0	1070	1076	0	1124	1113	1091	1148	1151
1.2	-5.5	-6.8	-5.4	-3.0	0.0	-3.4	-5.7	0.0	-5.7	-3.4	0.0	-3.0	-5.4	-6.8	-5.5	1.2
-1.9	-7.9	-7.7	-4.9	-1.4	0.0	-1.2	-4.4	0.0	-4.4	-1.2	0.0	-1.4	-4.9	-7.7	-7.9	-1.9
1156	1145	1113	0	1076	1177	1106	1097	1134	1097	1106	1177	1076	0	1113	1145	1156
1.2	-5.5	-5.4	0.0	2.7	4.5	2.2	-2.2	-5.3	-2.2	2.2	4.5	2.7	0.0	-5.4	-5.5	1.2
-0.5	-5.5	-4.9	0.0	2.2	4.2	2.7	-0.7	-3.6	-0.7	2.7	4.2	2.2	0.0	-4.9	-5.5	-0.5
1166	1168	1124	1076	1150	1125	1061	1053	1091	1053	1061	1125	1150	1076	1124	1168	1166
1.9	-4.5	-3.0	2.7	9.0	11.3	8.3	2.7	-2.2	2.7	8.3	11.3	9.0	2.7	-3.0	-4.5	1.9
2.7	-2.1	-1.4	2.2	6.7	8.5	6.8	3.4	0.8	3.4	6.8	8.5	6.7	2.2	-1.4	-2.1	2.7
1174	1199	0	1177	1125	0	1083	1078	0	1078	1083	0	1125	1177	0	1199	1174
2.1	-3.9	0.0	4.5	11.3	0.0	11.5	5.3	0.0	5.3	11.5	0.0	11.3	4.5	0.0	-3.9	2.1
4.3	-0.4	0.0	4.2	8.5	0.0	9.0	5.2	0.0	5.2	9.0	0.0	8.5	4.2	0.0	-0.4	4.3
1173	1164	1076	1106	1061	1083	1036	1033	1072	1033	1036	1083	1061	1106	1076	1164	1173
2.0	-4.6	-3.4	2.2	8.3	11.5	9.4	4.4	-0.4	4.4	9.4	11.5	8.3	2.2	-3.4	-4.6	2.0
2.9	-2.0	-1.2	2.7	6.8	9.0	7.3	3.8	1.2	3.8	7.3	9.0	6.8	2.7	-1.2	-2.0	2.9
1173	1161	1070	1097	1053	1078	1033	1030	1070	1030	1033	1078	1053	1097	1070	1161	1173
2.0	-5.2	-5.7	-2.2	2.7	5.3	4.4	1.2	-2.0	1.2	4.4	5.3	2.7	-2.2	-5.7	-5.2	2.0
0.5	-5.2	-4.4	-0.7	3.4	5.2	3.8	0.5	-2.0	0.5	3.8	5.2	3.4	-0.7	-4.4	-5.2	0.5
1175	1192	0	1134	1091	0	1072	1070	0	1070	1072	0	1091	1134	0	1192	1175
3.3	-3.2	0.0	-5.3	-2.2	0.0	-0.4	-2.0	0.0	-2.0	-0.4	0.0	-2.2	-5.3	0.0	-3.2	3.3
-0.1	-7.5	0.0	-3.6	0.8	0.0	1.2	-2.0	0.0	-2.0	1.2	0.0	0.8	-3.6	0.0	-7.5	-0.1
1173	1161	1070	1097	1053	1078	1033	1030	1070	1030	1033	1078	1053	1097	1070	1161	1173
2.0	-5.2	-5.7	-2.2	2.7	5.3	4.4	1.2	-2.0	1.2	4.4	5.3	2.7	-2.2	-5.7	-5.2	2.0
0.5	-5.2	-4.4	-0.7	3.4	5.2	3.8	0.5	-2.0	0.5	3.8	5.2	3.4	-0.7	-4.4	-5.2	0.5
1173	1164	1076	1106	1061	1083	1036	1033	1072	1033	1036	1083	1061	1106	1076	1164	1173
2.0	-4.6	-3.4	2.2	8.3	11.5	9.4	4.4	-0.4	4.4	9.4	11.5	8.3	2.2	-3.4	-4.6	2.0
2.9	-2.0	-1.2	2.7	6.8	9.0	7.3	3.8	1.2	3.8	7.3	9.0	6.8	2.7	-1.2	-2.0	2.9
1174	1199	0	1177	1125	0	1083	1078	0	1078	1083	0	1125	1177	0	1199	1174
2.1	-3.9	0.0	4.5	11.3	0.0	11.5	5.3	0.0	5.3	11.5	0.0	11.3	4.5	0.0	-3.9	2.1
4.3	-0.4	0.0	4.2	8.5	0.0	9.0	5.2	0.0	5.2	9.0	0.0	8.5	4.2	0.0	-0.4	4.3
1166	1168	1124	1076	1150	1125	1061	1053	1091	1053	1061	1125	1150	1076	1124	1168	1166
1.9	-4.5	-3.0	2.7	9.0	11.3	8.3	2.7	-2.2	2.7	8.3	11.3	9.0	2.7	-3.0	-4.5	1.9
2.7	-2.1	-1.4	2.2	6.7	8.5	6.8	3.4	0.8	3.4	6.8	8.5	6.7	2.2	-1.4	-2.1	2.7
1156	1145	1113	0	1076	1177	1106	1097	1134	1097	1106	1177	1076	0	1113	1145	1156
1.2	-5.5	-5.4	0.0	2.7	4.5	2.2	-2.2	-5.3	-2.2	2.2	4.5	2.7	0.0	-5.4	-5.5	1.2
-0.5	-5.5	-4.9	0.0	2.2	4.2	2.7	-0.7	-3.6	-0.7	2.7	4.2	2.2	0.0	-4.9	-5.5	-0.5
1151	1148	1091	1113	1124	0	1076	1070	0	1070	1076	0	1124	1113	1091	1148	1151
1.2	-5.5	-6.8	-5.4	-3.0	0.0	-3.4	-5.7	0.0	-5.7	-3.4	0.0	-3.0	-5.4	-6.8	-5.5	1.2
-1.9	-7.9	-7.7	-4.9	-1.4	0.0	-1.2	-4.4	0.0	-4.4	-1.2	0.0	-1.4	-4.9	-7.7	-7.9	-1.9
1164	1206	1148	1145	1168	1199	1164	1161	1192	1161	1164	1199	1168	1145	1148	1206	1164
2.5	-3.0	-5.5	-5.5	-4.5	-3.9	-4.6	-5.2	-3.2	-5.2	-4.6	-3.9	-4.5	-5.5	-5.5	-3.0	2.5
2.0	-6.3	-7.9	-5.5	-2.1	-0.4	-2.0	-5.2	-7.5	-5.2	-2.0	-0.4	-2.1	-5.5	-7.9	-6.3	2.0
1224	1164	1151	1156	1166	1174	1173	1173	1175	1173	1173	1174	1166	1156	1151	1164	1224
4.5	2.5	1.2	1.2	1.9	2.1	2.0	2.0	3.3	2.0	2.0	2.1	1.9	1.2	1.2	2.5	4.5
9.2	2.0	-1.9	-0.5	2.7	4.3	2.9	0.5	-0.1	0.5	2.9	4.3	2.7	-0.5	-1.9	2.0	9.2

Assembly power (het.) : 0.29720

Assembly power (1 n/ass.) : 0.29694

Assembly power (4 n/ass.) : 0.29891

Errors (1 n/ass.) Method 1: Av. 10.2% Max. 39.8% Method 2: Av. 8.6% Max. 22.8%

Errors (4 n/ass.) Method 1: Av. 4.2% Max. 11.5% Method 2: Av. 3.7% Max. 9.2%

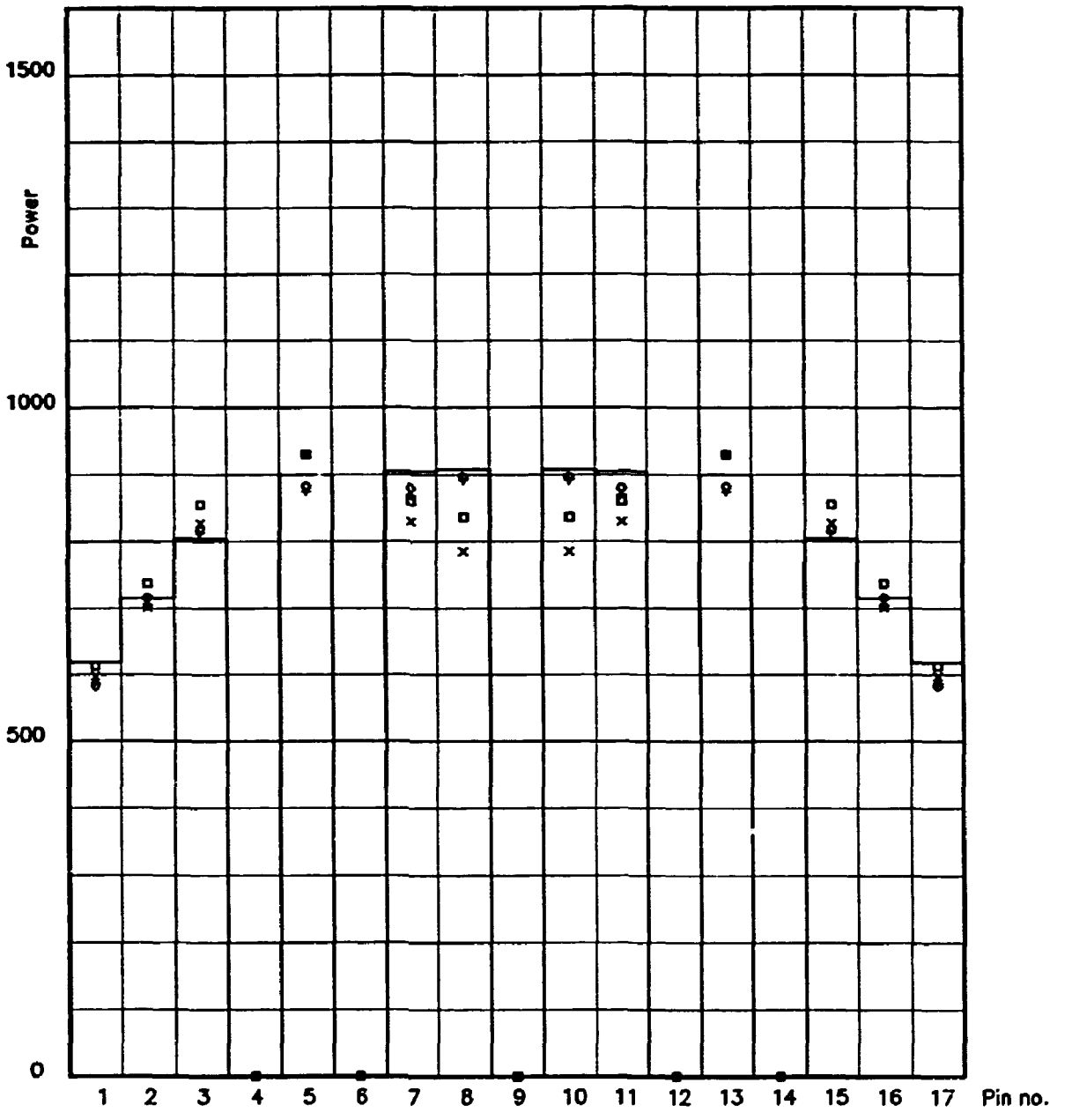
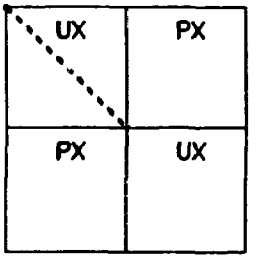


Figure 4.2.1

C2, UX assembly

Diagonal power traverse

- ——— *'Heterogeneous' calc.*
- × Method 1, 1 node /ass.
- \+ Method 1, 4 nodes/ass.
- □ Method 2, 1 node /ass.
- o Method 2, 4 nodes/ass.



Boundary: Infinite checkerboard

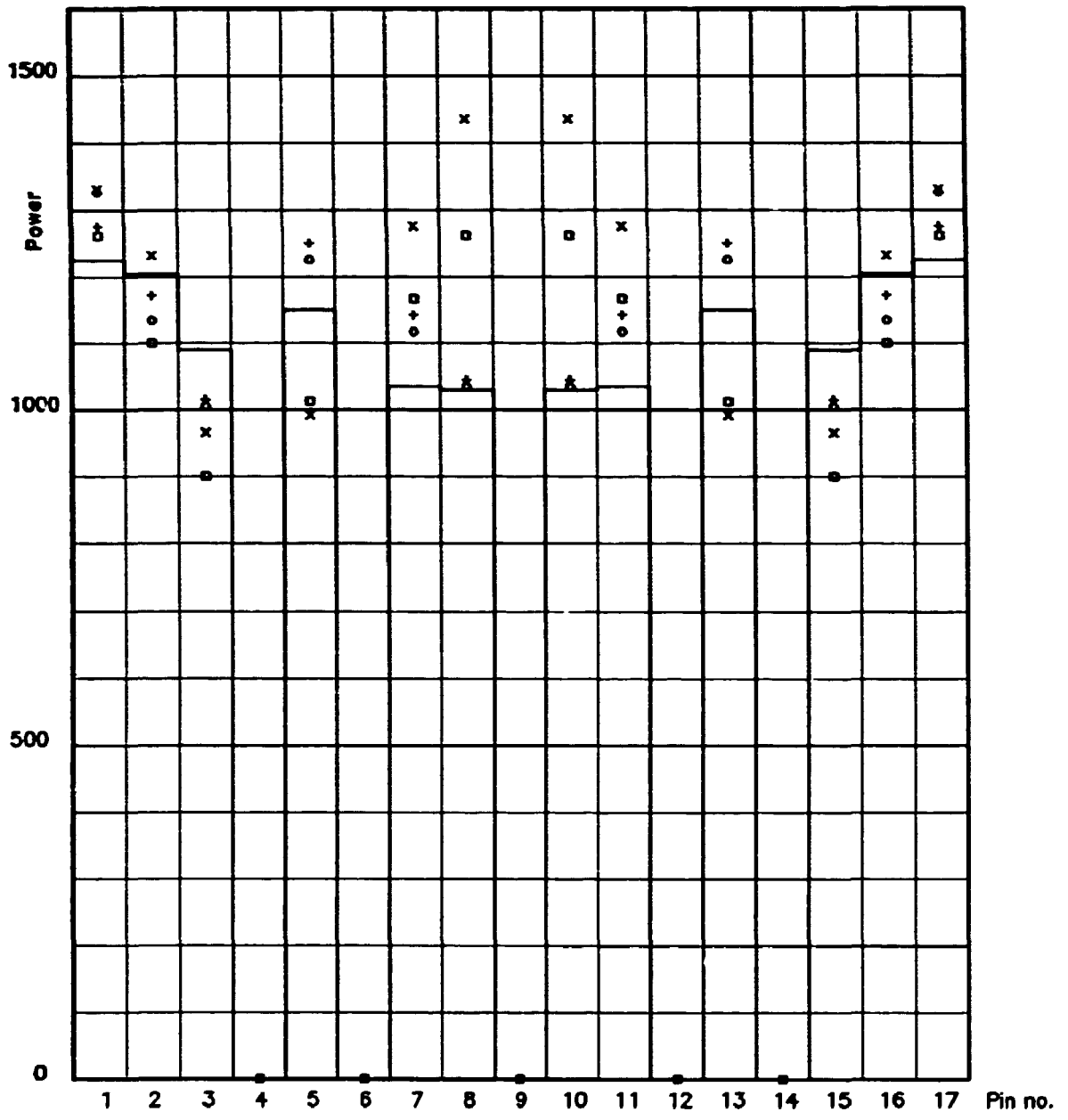


Figure 4.2.2

C2, PX assembly

Diagonal power traverse

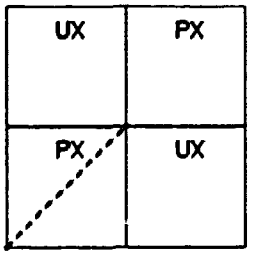
——— 'Heterogeneous' calc.

× Method 1, 1 node /ass.

· Method 1, 4 nodes/ass.

□ Method 2, 1 node /ass.

o Method 2, 4 nodes/ass.



Boundary: Infinite checkerboard

4.3 C3: UX/PX Reflected Checkerboard Configuration

k_{eff}(1 node/pin) = 1.01913
k_{eff}(1 node/assembly) = 1.01854
k_{eff}(4 nodes/assembly) = 1.01958

Assembly Powers:

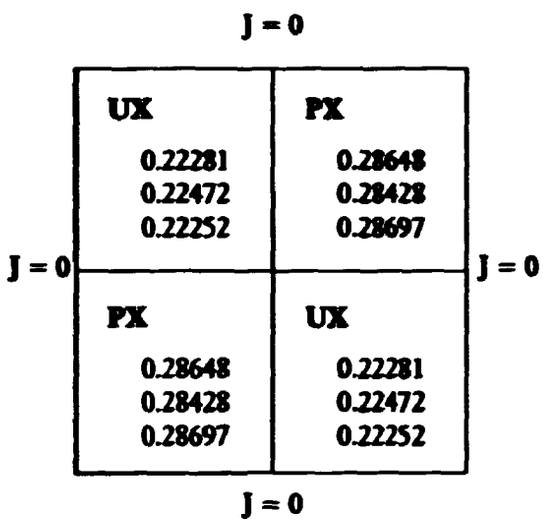


Table 4.3.1
C3, UX assembly.

821	823	829	836	844	850	852	855	858	859	860	859	852	836	809	761	671
0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.0	-0.6	-0.7	-0.4	0.2	0.6	0.1	-1.1
0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	-0.5	-0.6	-0.4	0.2	0.5	0.0	-1.1
823	828	837	848	862	874	868	878	880	874	876	884	869	847	816	764	672
0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.5	0.1	-0.6	-0.8	-0.4	0.2	0.6	0.1	-0.9
0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.4	0.1	-0.6	-0.7	-0.4	0.2	0.6	0.1	-0.9
829	837	854	877	890	0	888	889	0	893	895	0	898	876	833	772	675
0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.2	0.0	0.1	-0.5	0.0	-0.5	0.1	0.5	0.1	-0.8
0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	-0.5	0.0	-0.4	0.2	0.6	0.0	-0.8
836	848	877	0	901	897	885	886	897	890	893	906	908	0	855	782	679
0.1	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.4	0.1	-0.5	-0.7	-0.4	0.0	0.5	0.0	-0.7
0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.1	-0.6	-0.7	-0.4	0.0	0.5	0.1	-0.6
844	862	890	901	898	900	889	889	900	893	896	909	904	899	867	794	685
0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.4	0.5	0.2	-0.5	-0.7	-0.4	0.4	0.6	0.1	-0.7
0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.2	0.4	0.1	-0.5	-0.7	-0.4	0.4	0.6	0.1	-0.6
850	874	0	897	900	0	900	901	0	905	907	0	906	894	0	805	689
0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.2	0.0	0.1	-0.5	0.0	-0.2	0.5	0.0	0.1	-0.6
0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.2	0.0	0.0	-0.6	0.0	-0.2	0.5	0.0	0.1	-0.6
852	868	888	885	889	900	892	894	905	897	898	907	894	881	842	797	689
0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.2	0.0	-0.5	-0.6	-0.2	0.6	0.0	0.4	-0.5
0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.4	0.1	-0.5	-0.6	-0.2	0.5	0.8	0.4	-0.5
855	870	889	886	889	901	894	895	906	899	899	908	894	881	842	798	690
0.1	0.2	0.2	0.2	0.4	0.2	0.1	0.2	0.2	-0.1	-0.5	-0.7	-0.2	0.5	0.8	0.4	-0.5
0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.4	0.4	0.0	-0.5	-0.7	-0.2	0.5	0.8	0.4	-0.5
858	880	0	897	900	0	905	906	0	909	910	0	904	890	0	806	691
0.2	0.5	0.0	0.4	0.5	0.0	0.2	0.2	0.0	-0.1	-0.7	0.0	-0.2	0.6	0.0	0.2	-0.6
0.2	0.4	0.0	0.2	0.4	0.0	0.4	0.4	0.0	-0.2	-1.1	0.0	-0.8	0.4	0.0	1.1	0.1
859	874	893	890	893	905	897	899	909	901	902	910	896	882	864	799	691
0.0	0.1	0.1	0.1	0.2	0.1	0.0	-0.1	-0.1	-1.2	-2.4	-2.6	-1.0	-0.1	1.2	1.4	0.4
0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.0	-0.2	-1.1	-2.1	-2.4	-1.8	-0.4	0.8	1.3	0.6
860	876	895	893	896	907	898	899	910	902	903	911	897	884	865	799	691
-0.6	-0.6	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.7	-2.4	-4.0	-4.5	-3.3	-1.2	0.8	1.0	0.9
-0.5	-0.6	-0.5	-0.6	-0.5	-0.5	-0.5	-0.5	-1.1	-2.1	-3.1	-3.3	-2.6	-1.2	0.0	0.6	0.1
859	884	0	906	909	0	907	908	0	910	911	0	909	897	0	807	691
-0.7	-0.8	0.0	-0.7	-0.7	0.0	-0.6	-0.7	0.0	-2.6	-4.5	0.0	-4.0	-1.7	0.0	1.9	1.2
-0.6	-0.7	0.0	-0.7	-0.7	0.0	-0.6	-0.7	0.0	-2.4	-3.3	0.0	-2.8	-1.5	0.0	0.2	0.8
852	869	898	908	904	906	894	894	904	896	897	909	904	899	867	794	686
-0.4	-0.4	-0.5	-0.4	-0.4	-0.2	-0.2	-0.2	-0.2	-1.0	-3.3	-4.0	-3.1	-1.1	0.9	1.9	1.1
-0.4	-0.4	-0.4	-0.4	-0.4	-0.2	-0.2	-0.2	-0.8	-1.8	-2.6	-2.8	-2.1	-0.9	0.2	0.7	0.4
836	847	876	0	899	894	881	881	890	882	884	897	899	0	847	777	678
0.2	0.2	0.1	0.0	0.4	0.5	0.6	0.5	0.6	-0.1	-1.2	-1.7	-1.1	0.0	1.4	1.5	0.4
0.2	0.2	0.2	0.0	0.4	0.5	0.5	0.5	0.4	-0.4	-1.2	-1.5	-0.9	0.0	1.3	1.4	0.7
809	816	833	855	867	0	862	862	0	864	865	0	867	847	809	755	668
0.6	0.6	0.5	0.5	0.6	0.0	0.8	0.8	0.0	1.2	0.8	0.0	0.9	1.4	1.4	0.6	-0.8
0.5	0.6	0.6	0.5	0.6	0.0	0.8	0.8	0.0	0.8	0.0	0.0	0.2	1.3	1.9	1.7	0.2
761	764	772	782	794	805	797	798	806	799	799	807	794	777	755	720	653
0.1	0.1	0.1	0.0	0.1	0.1	0.4	0.4	0.2	1.4	1.8	1.9	1.9	1.5	0.6	-1.1	-2.5
0.0	0.1	0.0	0.1	0.1	0.1	0.4	0.4	1.1	1.3	0.6	0.2	0.7	1.4	1.7	0.6	-1.5
671	672	675	679	685	689	689	690	691	691	691	691	686	678	668	653	623
-1.1	-0.9	-0.8	-0.7	-0.7	-0.6	-0.5	-0.5	-0.6	0.4	0.9	1.2	1.1	0.4	-0.8	-2.5	-3.6
-1.1	-0.9	-0.8	-0.6	-0.6	-0.6	-0.5	-0.5	0.1	0.6	0.1	0.0	0.4	0.7	0.2	-1.5	-3.9

Assembly power (het.) : 0.22281

Assembly power (1 n/ass.) : 0.22472

Assembly power (4 n/ass.) : 0.22252

Errors (1 n/ass.) Method 1: Av. 4.1% Max.-12.1% Method 2: Av. 3.1% Max. 10.1%

Errors (4 n/ass.) Method 1: Av. 0.6% Max. -4.5% Method 2: Av. 0.5% Max. -3.9%

Table 4.3.2
C3, PX assembly

1163	1156	1155	1162	1173	1180	1179	1180	1183	1181	1182	1184	1176	1166	1161	1175	1235
3.2	2.7	2.2	2.1	2.3	2.6	2.7	2.8	2.9	1.7	1.8	2.2	2.1	1.7	1.8	3.8	5.1
3.5	3.0	2.7	2.6	2.5	2.6	2.2	1.9	1.2	1.2	3.3	4.5	2.9	-0.6	-1.9	1.0	9.5
981	1138	1132	1146	1174	1207	1172	1171	1202	1172	1174	1211	1179	1157	1160	1210	1175
-2.3	-3.5	-3.6	-3.6	-3.4	-3.1	-3.2	-3.2	-3.2	-5.4	-5.0	-4.3	-4.7	-5.6	-5.4	-2.7	3.8
-2.1	-3.2	-3.2	-3.2	-3.1	-3.1	-3.5	-4.0	-5.4	-4.8	-1.8	-0.4	-2.2	-5.9	-8.4	-6.8	1.8
910	1069	1064	1118	1130	0	1086	1081	0	1082	1088	0	1136	1125	1103	1160	1161
-3.2	-4.0	-3.9	-3.9	-4.0	0.0	-4.1	-4.4	0.0	-5.4	-3.5	0.0	-3.4	-5.8	-7.2	-5.4	1.0
-3.1	-3.9	-3.8	-3.9	-4.0	0.0	-4.1	-4.6	0.0	-4.1	-1.1	0.0	-1.5	-5.1	-8.2	-8.4	-1.9
889	1031	1088	0	1083	1189	1119	1111	1148	1111	1120	1191	1089	0	1125	1157	1166
-0.9	-1.1	-1.8	0.0	-1.2	-1.7	-1.8	-2.4	-3.4	-1.2	2.5	4.4	2.2	0.0	-5.0	-5.6	1.7
-1.0	-1.2	-1.3	0.0	-1.4	-1.7	-1.7	-2.0	-2.7	-0.3	2.9	4.4	2.3	0.0	-5.1	-5.9	-0.6
888	1067	1088	1072	1158	1138	1075	1068	1106	1067	1075	1139	1164	1089	1136	1179	1176
2.8	2.4	2.6	2.4	2.6	2.3	1.8	1.1	0.1	4.1	9.0	11.6	0.8	2.2	-3.4	-4.7	2.1
1.8	2.1	2.2	2.1	2.3	2.3	2.0	1.8	1.6	4.1	7.3	9.0	7.0	2.3	-1.5	-2.2	2.9
892	1075	0	1172	1135	0	1099	1096	0	1096	1098	0	1139	1191	0	1211	1184
3.3	4.1	0.0	4.4	4.2	0.0	3.6	2.9	0.0	6.7	12.5	0.0	11.6	4.4	0.0	-4.3	2.2
3.1	3.9	0.0	4.1	4.1	0.0	3.9	3.5	0.0	5.9	9.5	0.0	9.0	4.4	0.0	-0.4	4.5
889	1041	1041	1103	1072	1099	1053	1050	1009	1049	1051	1098	1075	1120	1088	1174	1182
2.3	2.7	2.7	2.9	2.8	2.9	2.4	2.0	1.2	5.4	18.4	12.5	9.8	2.5	-3.5	-5.0	1.8
2.2	2.5	2.5	2.7	2.7	2.9	2.6	2.3	2.0	4.5	7.8	9.5	7.3	2.9	-1.1	-1.8	3.3
890	1039	1036	1096	1046	1096	1051	1049	1008	1048	1049	1094	1067	1111	1082	1172	1181
-0.1	-0.1	-0.3	-0.3	-0.2	-0.2	-0.1	-0.4	-1.2	1.8	5.4	6.7	4.1	-1.2	-5.4	-5.4	1.7
-0.2	-0.1	-0.2	-0.2	-0.1	-0.2	-0.2	-0.4	-0.9	1.3	4.5	5.9	4.1	-0.3	-4.1	-4.8	1.2
893	1070	0	1133	1186	0	1092	1089	0	1088	1089	0	1106	1148	0	1202	1183
-1.2	-1.6	0.0	-1.8	-1.7	0.0	-1.7	-1.0	0.0	-1.2	1.2	0.0	0.1	-3.4	0.0	-3.2	2.9
-1.3	-1.6	0.0	-1.8	-1.7	0.0	-1.7	-1.9	0.0	-0.9	2.0	0.0	1.6	-2.7	0.0	-5.4	1.2
892	1042	1039	1098	1048	1098	1053	1050	1009	1049	1050	1094	1068	1111	1081	1171	1180
-0.6	-0.7	-0.8	-0.8	-0.7	-0.7	-0.6	-0.8	-1.8	-0.4	2.0	2.9	1.1	-2.4	-4.4	-3.2	2.8
-0.6	-0.6	-0.8	-0.7	-0.6	-0.7	-0.7	-1.0	-1.9	-0.4	2.3	3.5	1.8	-2.0	-4.6	-4.0	1.9
893	1045	1045	1107	1076	1103	1056	1053	1092	1051	1053	1099	1075	1119	1086	1172	1179
-0.2	-0.3	-0.4	-0.4	-0.3	-0.2	-0.3	-0.6	-1.7	-0.1	2.4	3.6	1.8	-1.8	-4.1	-3.2	2.7
-0.2	-0.3	-0.4	-0.4	-0.3	-0.2	-0.3	-0.7	-1.7	-0.2	2.6	3.9	2.0	-1.7	-4.1	-3.5	2.2
896	1081	0	1177	1140	0	1103	1098	0	1096	1099	0	1138	1189	0	1207	1180
-0.1	-0.2	0.0	-0.3	-0.2	0.0	-0.2	-0.7	0.0	-0.2	2.9	0.0	2.3	-1.7	0.0	-3.1	2.6
-0.1	-0.2	0.0	-0.3	-0.2	0.0	-0.2	-0.7	0.0	-0.2	2.9	0.0	2.3	-1.7	0.0	-3.1	2.6
891	1050	1091	1074	1160	1140	1076	1068	1106	1066	1072	1135	1158	1083	1130	1174	1173
-0.1	-0.2	-0.3	-0.3	-0.2	-0.2	-0.3	-0.7	-1.7	-0.2	2.8	4.2	2.6	-1.2	-4.0	-3.4	2.3
-0.1	-0.2	-0.3	-0.3	-0.3	-0.2	-0.3	-0.6	-1.7	-0.1	2.7	4.1	2.3	-1.4	-4.0	-3.1	2.5
884	1026	1073	0	1074	1177	1107	1098	1133	1096	1103	1172	1072	0	1110	1146	1162
-0.2	-0.2	-0.3	0.0	-0.3	-0.3	-0.4	-0.8	-1.8	-0.3	2.9	4.4	2.4	0.0	-3.9	-3.6	2.1
-0.2	-0.3	-0.3	0.0	-0.3	-0.3	-0.4	-0.7	-1.8	-0.2	2.7	4.1	2.1	0.0	-3.9	-3.2	2.6
880	1012	1028	1073	1091	0	1045	1039	0	1036	1041	0	1088	1080	1064	1132	1155
-0.2	-0.3	-0.3	-0.3	-0.3	0.0	-0.4	-0.8	0.0	-0.3	2.7	0.0	2.6	-1.0	-3.9	-3.6	2.2
-0.2	-0.3	-0.3	-0.3	-0.3	0.0	-0.4	-0.8	0.0	-0.2	2.5	0.0	2.2	-1.3	-3.8	-3.2	2.7
884	1018	1012	1024	1050	1081	1045	1042	1070	1039	1041	1075	1047	1031	1049	1138	1156
-0.2	-0.3	-0.3	-0.2	-0.2	-0.2	-0.3	-0.7	-1.6	-0.1	2.7	4.1	2.4	-1.1	-4.0	-3.5	2.7
-0.2	-0.3	-0.3	-0.3	-0.2	-0.2	-0.3	-0.6	-1.6	-0.1	2.5	3.9	2.1	-1.2	-3.9	-3.2	3.0
893	884	880	884	891	896	893	892	893	890	889	892	888	889	910	981	1163
-0.1	-0.2	-0.2	-0.2	-0.1	-0.1	-0.2	-0.6	-1.2	-0.1	2.3	3.3	2.0	-0.9	-3.2	-2.3	3.2
-0.1	-0.2	-0.2	-0.2	-0.1	-0.1	-0.2	-0.6	-1.3	-0.2	2.2	3.1	1.8	-1.0	-3.1	-2.1	3.5

Assembly power (Ref.) : 0.28648

Assembly power (1 n/ass.) : 0.28428

Assembly power (4 n/ass.) : 0.28697

Errors (1 n/ass.) Method 1: Av. 11.6% Max. 34.3% Method 2: Av. 9.9% Max.-27.3%

Errors (4 n/ass.) Method 1: Av. 2.4% Max. 12.5% Method 2: Av. 2.3% Max. 9.5%

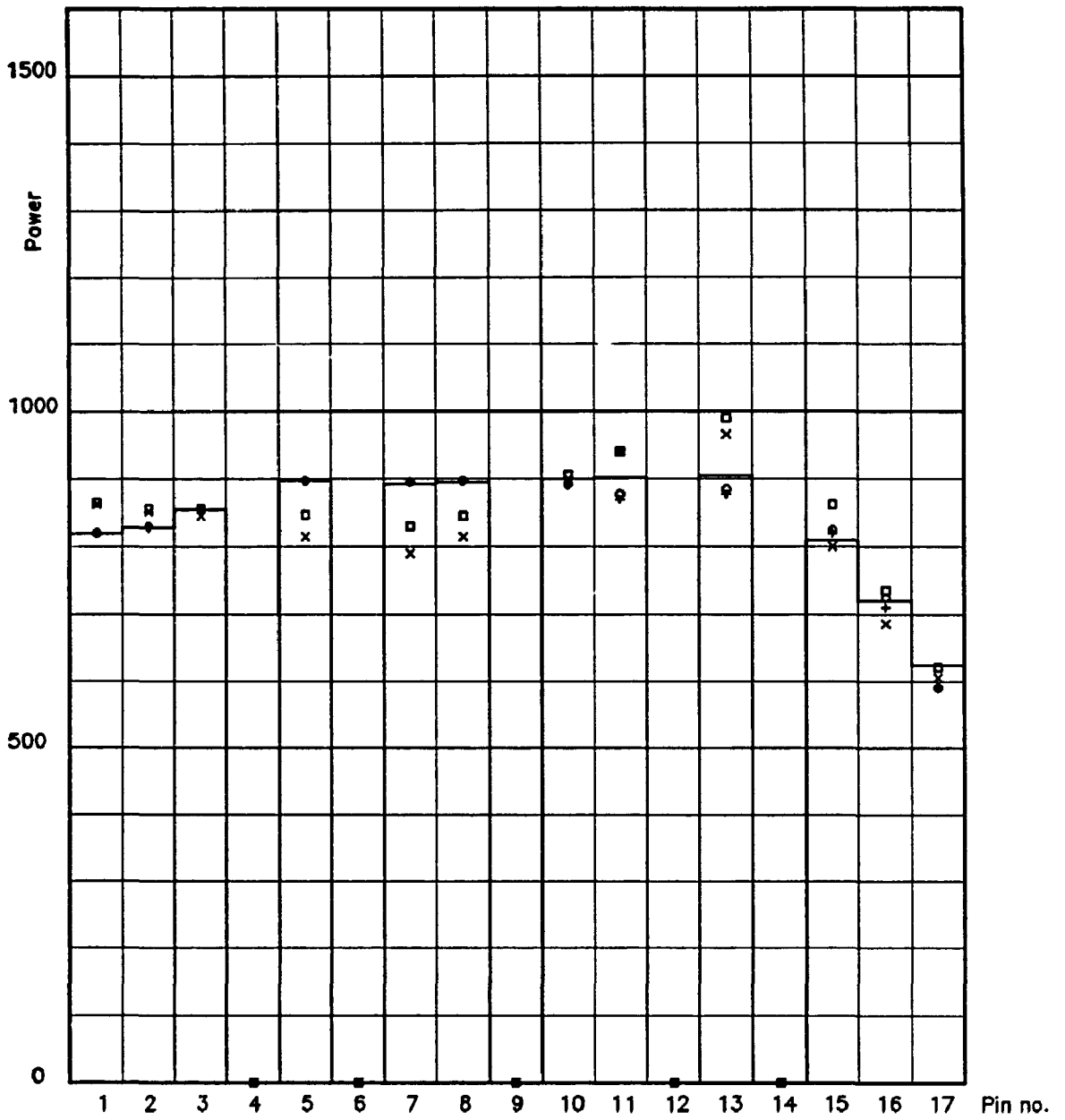


Figure 4.3.1

C3, UX assembly

Diagonal power traverse

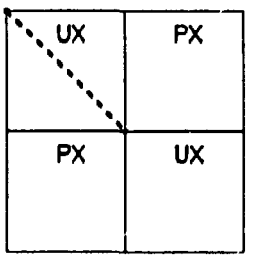
——— 'Heterogeneous' calc.

x Method 1, 1 node /ass.

\+ Method 1, 4 nodes/ass.

□ Method 2, 1 node /ass.

o Method 2, 4 nodes/ass.



Boundary: Reflective

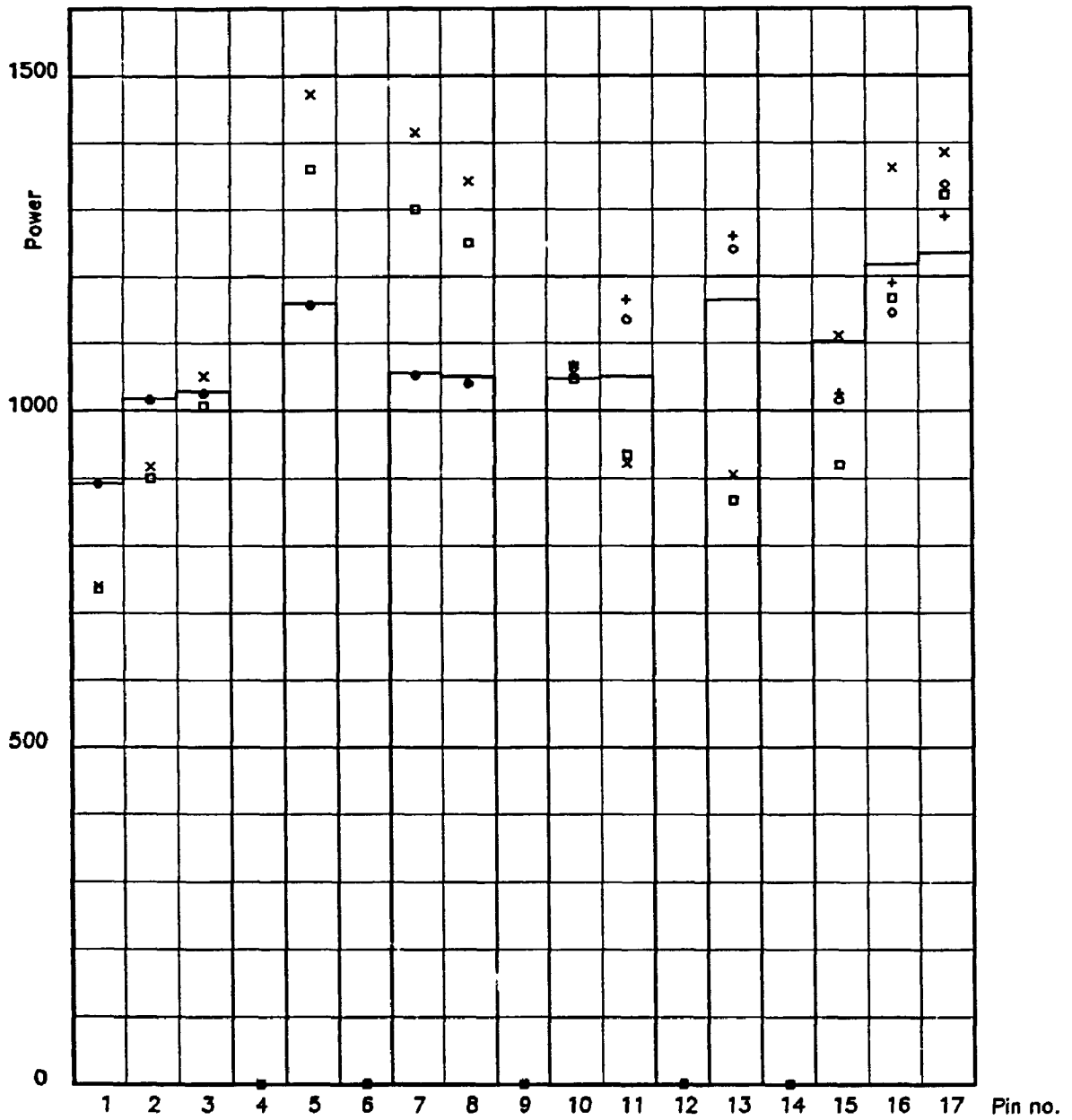


Figure 4.3.2

C3, PX assembly

Diagonal power traverse

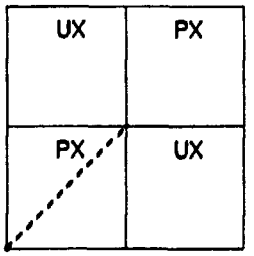
——— 'Heterogeneous' calc.

× Method 1, 1 node /ass.

\+ Method 1, 4 nodes/ass.

□ Method 2, 1 node /ass.

○ Method 2, 4 nodes/ass.



Boundary: Reflective

4.4 UX/PX Semi-Reflected Checkerboard Configuration

4.4.1 C4: Zero Flux Boundary

k_{eff}(1 node/pin) = 0.90680
k_{eff}(1 node/assembly) = 0.90813
k_{eff}(4 nodes/assembly) = 0.90780

Assembly Powers:

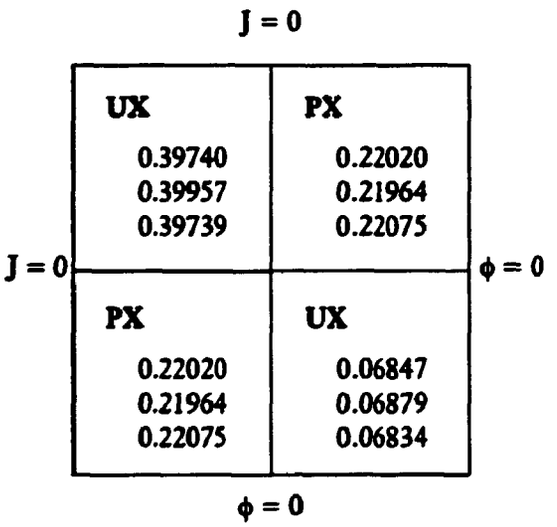


Table 4.4.1
C4, UX assembly, upper left.

1780	1782	1786	1790	1791	1784	1764	1742	1717	1685	1650	1610	1555	1484	1394	1270	1083
-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.1	0.1	0.3	0.1	-0.3	-0.4	-0.1	0.3	0.5	0.1	-0.7
-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1	0.1	0.3	0.3	-0.3	-0.5	-0.2	0.3	0.5	0.1	-0.8
1782	1788	1798	1810	1823	1830	1793	1769	1759	1712	1676	1651	1583	1501	1403	1274	1082
-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.1	0.2	0.3	0.2	-0.3	-0.5	-0.3	0.2	0.5	0.1	-0.6
-0.1	-0.1	-0.1	0.0	0.0	0.0	0.1	0.2	0.3	0.2	-0.2	-0.4	-0.3	0.2	0.5	0.1	-0.7
1786	1798	1827	1862	1875	0	1826	1800	0	1742	1707	0	1628	1544	1427	1281	1083
-0.1	-0.1	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.2	-0.3	0.0	-0.3	0.2	0.4	0.1	-0.6
-0.1	-0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	-0.3	0.0	-0.3	0.3	0.4	0.1	-0.6
1790	1810	1862	0	1886	1857	1809	1782	1772	1724	1690	1675	1636	0	1455	1290	1084
-0.1	-0.1	0.0	0.0	0.0	0.1	0.1	0.3	0.5	0.3	-0.2	-0.5	-0.3	0.0	0.3	0.1	-0.5
-0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.2	0.4	0.2	-0.2	-0.5	-0.2	0.0	0.4	0.1	-0.5
1791	1823	1875	1886	1862	1847	1800	1773	1764	1715	1682	1665	1614	1562	1463	1299	1085
0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.4	-0.2	-0.4	-0.2	0.3	0.5	0.1	-0.5
-0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.3	0.4	0.3	-0.2	-0.4	-0.1	0.3	0.5	0.1	-0.5
1784	1830	0	1857	1847	0	1803	1777	0	1719	1684	0	1602	1536	0	1304	1080
0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.3	0.0	0.3	-0.1	0.0	-0.2	0.5	0.0	0.1	-0.5
0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.3	0.0	0.3	-0.1	0.0	-0.1	0.5	0.0	0.1	-0.5
1764	1793	1826	1809	1800	1803	1764	1740	1731	1683	1648	1626	1561	1496	1422	1276	1067
0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.3	-0.2	-0.4	-0.1	0.5	0.7	0.2	-0.3
0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.3	-0.1	-0.4	-0.1	0.5	0.7	0.2	-0.3
1742	1769	1800	1782	1773	1777	1740	1716	1708	1660	1625	1602	1537	1473	1401	1258	1052
0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.2	-0.1	-0.2	0.1	0.6	0.7	0.3	-0.2
0.1	0.2	0.1	0.2	0.3	0.3	0.3	0.4	0.5	0.3	-0.1	-0.3	0.0	0.5	0.7	0.3	-0.2
1717	1759	0	1772	1764	0	1731	1708	0	1652	1616	0	1528	1463	0	1250	1037
0.3	0.3	0.0	0.5	0.5	0.0	0.4	0.3	0.0	0.2	0.0	0.0	0.3	0.8	0.0	0.2	-0.3
0.3	0.3	0.0	0.4	0.4	0.0	0.4	0.5	0.0	0.1	-0.3	0.0	-0.1	0.6	0.0	0.7	0.1
1685	1712	1742	1724	1715	1719	1683	1660	1652	1605	1571	1549	1485	1423	1354	1215	1017
0.1	0.2	0.2	0.3	0.4	0.3	0.3	0.2	0.2	-0.2	-0.8	-0.9	-0.4	0.5	0.9	0.7	0.1
0.3	0.2	0.1	0.2	0.3	0.3	0.3	0.3	0.1	-0.1	-0.7	-1.1	-0.6	0.3	0.9	0.9	0.3
1650	1676	1707	1690	1682	1684	1648	1625	1616	1571	1538	1517	1456	1395	1326	1190	995
-0.3	-0.3	-0.3	-0.2	-0.2	-0.1	-0.2	-0.1	0.0	-0.8	-1.6	-1.9	-1.3	-0.2	0.7	0.7	0.0
-0.3	-0.2	-0.3	-0.2	-0.2	-0.1	-0.1	-0.1	-0.3	-0.7	-1.3	-1.6	-1.2	-0.3	0.3	0.4	0.1
1610	1651	0	1675	1665	0	1626	1602	0	1549	1517	0	1441	1382	0	1174	972
-0.4	-0.5	0.0	-0.5	-0.4	0.0	-0.4	-0.2	0.0	-0.9	-1.9	0.0	-1.7	-0.5	0.0	0.4	-0.2
-0.5	-0.4	0.0	-0.5	-0.4	0.0	-0.4	-0.3	0.0	-1.1	-1.6	0.0	-1.4	-0.5	0.0	0.1	-0.1
1555	1583	1628	1636	1614	1602	1561	1537	1528	1485	1456	1441	1395	1350	1267	1126	941
-0.1	-0.3	-0.3	-0.3	-0.2	-0.2	-0.1	0.1	0.3	-0.4	-1.3	-1.7	-1.1	-0.2	0.4	0.4	-0.3
-0.2	-0.3	-0.3	-0.2	-0.1	-0.1	-0.1	0.0	-0.1	-0.6	-1.2	-1.4	-0.9	-0.3	0.2	0.2	-0.1
1484	1501	1544	0	1562	1536	1496	1473	1463	1423	1395	1382	1350	0	1204	1070	903
0.3	0.2	0.2	0.0	0.3	0.5	0.5	0.6	0.8	0.5	-0.2	-0.5	-0.2	0.0	0.7	0.5	-0.3
0.3	0.2	0.3	0.0	0.3	0.5	0.5	0.5	0.6	0.3	-0.3	-0.5	-0.3	0.0	0.7	0.6	0.1
1394	1403	1427	1455	1463	0	1422	1401	0	1354	1326	0	1267	1204	1116	1007	860
0.5	0.5	0.4	0.3	0.5	0.0	0.7	0.7	0.0	0.9	0.7	0.0	0.4	0.7	0.7	0.3	-0.5
0.5	0.5	0.4	0.4	0.5	0.0	0.7	0.7	0.0	0.9	0.3	0.0	0.2	0.7	0.9	0.7	-0.3
1270	1274	1281	1290	1299	1304	1276	1258	1250	1215	1190	1174	1126	1070	1007	927	809
0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.2	0.7	0.7	0.4	0.4	0.5	0.3	-0.3	-0.9
0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.7	0.9	0.4	0.1	0.2	0.6	0.7	0.0	-1.3
1083	1082	1083	1084	1085	1080	1067	1052	1037	1017	995	972	941	903	860	809	738
-0.7	-0.6	-0.6	-0.5	-0.5	-0.5	-0.3	-0.2	-0.3	0.1	0.0	-0.2	-0.3	-0.3	-0.5	-0.9	-1.5
-0.8	-0.7	-0.6	-0.5	-0.5	-0.5	-0.3	-0.2	0.1	0.3	0.1	-0.1	-0.1	0.1	-0.3	-1.3	-2.7

Assembly power (het.) : 0.39740

Assembly power (1 n/ass.) : 0.39957

Assembly power (4 n/ass.) : 0.39739

Errors (1 n/ass.) Method 1: Av. 2.3% Max. -7.1% Method 2: Av. 2.2% Max. 6.6%

Errors (4 n/ass.) Method 1: Av. 0.3% Max. -1.9% Method 2: Av. 0.3% Max. -2.7%

Table 4.4.2
C4, PX assembly.

1806	1792	1784	1784	1785	1778	1756	1731	1707	1673	1638	1601	1550	1491	1433	1389	1387
8.8	6.8	5.5	4.9	5.2	5.9	6.1	7.0	7.7	4.8	3.0	2.2	1.6	1.8	3.5	6.2	6.7
8.2	7.1	6.5	6.4	6.5	6.4	5.5	5.0	4.0	2.0	4.8	6.6	4.3	-0.1	-1.8	3.6	13.4
1445	1674	1658	1667	1693	1724	1657	1631	1646	1576	1544	1552	1473	1401	1354	1359	1243
-3.6	-6.5	-6.8	-7.0	-6.6	-5.0	-6.1	-5.3	-4.1	-8.0	-8.4	-8.2	-9.0	-9.5	-8.3	-4.3	1.9
-4.1	-6.2	-6.0	-5.8	-5.4	-5.4	-6.5	-7.0	-9.2	-9.2	-4.9	-2.5	-4.8	-9.1	-12.0	-9.6	1.9
1262	1451	1464	1516	1536	0	1451	1423	0	1375	1350	0	1338	1280	1211	1216	1156
-6.0	-7.4	-7.1	-7.0	-7.7	0.0	-8.5	-8.5	0.0	-9.8	-7.3	0.0	-7.0	-8.9	-10.1	-7.4	1.6
-6.4	-7.4	-7.0	-6.6	-7.4	0.0	-8.5	-8.9	0.0	-8.4	-4.2	0.0	-4.1	-7.7	-11.4	-11.4	-3.2
1156	1337	1395	0	1387	1513	1406	1375	1400	1329	1309	1359	1205	0	1161	1139	1091
-1.6	-1.4	-1.1	0.0	-2.0	-3.5	-3.8	-4.8	-7.0	-4.1	1.2	3.8	2.3	0.0	-6.8	-5.9	3.8
-1.6	-1.7	-1.6	0.0	-2.5	-3.7	-3.6	-3.8	-4.9	-1.6	2.4	4.1	2.4	0.0	-5.9	-6.7	-0.5
1079	1268	1314	1294	1387	1346	1257	1230	1252	1188	1169	1209	1206	1093	1095	1086	1030
4.2	5.8	6.5	5.8	6.1	5.9	4.2	2.6	0.6	5.3	12.2	16.1	12.8	4.8	-1.7	-3.0	6.1
4.6	5.5	5.6	4.7	5.0	5.3	4.7	4.2	4.4	7.2	10.9	12.8	10.1	4.7	0.8	-0.2	5.0
1007	1212	0	1315	1262	0	1195	1171	0	1132	1111	0	1098	1110	0	1039	964
6.8	9.0	0.0	10.0	9.7	0.0	7.8	6.2	0.0	10.0	17.6	0.0	17.3	9.1	0.0	-2.3	6.1
7.3	8.8	0.0	8.8	8.6	0.0	8.2	7.7	0.0	10.6	14.4	0.0	13.1	8.5	0.0	2.9	7.9
925	1083	1082	1140	1099	1118	1056	1037	1061	1002	982	1004	955	962	901	930	888
4.8	5.8	5.8	6.4	6.2	5.9	5.2	4.2	2.4	7.9	14.1	16.8	13.2	5.9	-1.8	-4.1	3.8
5.2	5.8	5.4	5.8	5.6	5.5	5.3	4.9	4.6	7.4	10.7	12.0	9.7	5.9	1.6	0.7	6.2
844	983	976	1028	992	1008	957	941	959	909	890	905	861	866	812	844	810
0.0	0.2	0.2	0.2	0.4	0.5	0.2	0.1	-0.6	2.6	6.7	8.3	5.3	0.1	-4.7	-5.5	1.4
0.1	0.4	0.4	0.2	0.4	0.5	0.2	0.0	-0.5	1.7	4.7	6.0	4.2	0.8	-2.5	-3.4	2.5
765	915	0	960	929	0	899	884	0	854	835	0	807	809	0	783	733
-2.8	-3.5	0.0	-4.0	-3.7	0.0	-3.4	-3.2	0.0	-2.9	-1.3	0.0	-2.4	-4.3	0.0	-2.9	1.7
-2.9	-3.5	0.0	-3.7	-3.4	0.0	-3.6	-3.6	0.0	-2.6	-0.1	0.0	-0.6	-3.5	0.0	-5.6	-0.2
679	793	789	828	799	816	772	760	778	733	718	732	694	697	656	679	650
-1.7	-2.2	-2.4	-2.2	-2.0	-2.4	-2.0	-2.3	-3.1	-2.2	-1.4	-1.7	-2.3	-3.4	-3.5	-1.7	1.8
-1.6	-2.0	-2.3	-2.2	-2.0	-2.4	-2.2	-2.3	-3.5	-2.2	-0.4	0.2	-0.6	-2.8	-4.6	-4.0	0.2
592	690	684	722	696	706	670	659	671	636	623	633	603	607	568	590	567
-1.0	-0.8	-0.2	-0.4	-0.2	-0.1	-0.5	-0.8	-1.2	-1.1	-0.6	-0.5	-1.2	-1.8	-1.4	-0.2	1.8
-0.6	-0.6	-0.2	-0.5	-0.4	-0.2	-0.6	-0.7	-1.6	-1.1	0.6	1.6	0.5	-1.4	-2.8	-2.8	0.4
507	608	0	652	626	0	597	586	0	566	554	0	543	548	0	520	484
-1.1	-0.7	0.0	0.1	0.2	0.0	-0.5	-0.8	0.0	-1.3	-0.6	0.0	-0.8	-1.3	0.0	-0.2	1.3
-0.6	-0.5	0.0	-0.1	0.0	0.0	-0.5	-0.7	0.0	-1.2	0.6	0.0	0.6	-1.1	0.0	-2.5	0.4
415	490	506	488	523	514	479	469	480	452	445	460	453	410	420	418	397
-1.1	-1.3	-1.0	0.1	0.2	-0.4	-0.5	-0.8	-1.6	-1.0	-0.5	-0.2	-0.2	-0.7	-1.6	-0.8	0.5
-0.7	-1.1	-1.0	-0.1	-0.1	-0.6	-0.6	-0.7	-1.7	-0.8	0.4	0.8	0.7	-0.7	-2.6	-2.3	0.1
322	373	390	0	378	405	377	368	372	355	350	362	326	0	323	319	308
-1.0	-1.1	-1.1	0.0	0.0	0.6	0.4	0.2	0.0	0.2	1.1	1.7	0.7	0.0	-1.6	-1.3	-0.1
-0.7	-1.0	-1.1	0.0	-0.2	0.4	0.4	0.2	0.1	0.4	1.3	1.9	0.7	0.0	-2.0	-1.8	0.1
229	264	270	282	280	0	256	250	0	241	237	0	242	237	224	226	219
-0.5	-0.7	-1.2	-1.4	-0.8	0.0	0.0	0.0	0.0	0.4	1.6	0.0	1.1	-0.7	-1.9	-2.2	-0.5
-0.6	-0.7	-1.2	-1.4	-0.8	0.0	0.0	0.0	0.0	0.4	1.1	0.0	0.2	-1.1	-1.4	-1.1	0.4
137	158	157	160	163	167	156	153	157	147	145	150	141	134	130	135	131
0.2	0.0	-0.4	-0.8	-1.0	-1.0	-0.4	-0.2	-0.8	0.4	2.0	2.8	2.3	0.2	-1.9	-3.1	-1.0
-0.2	-0.2	-0.4	-0.6	-0.6	-0.7	-0.2	-0.4	-0.6	0.4	0.6	0.4	0.2	-0.1	-0.4	-0.2	0.6
46	45	44	45	45	45	44	43	43	41	41	40	39	37	37	38	43
0.8	0.5	0.1	-0.4	-0.5	-0.5	-0.2	-0.1	-0.4	0.7	2.6	3.8	3.1	0.6	-2.6	-4.4	-1.9
0.0	0.0	0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.2	0.2	0.4	0.2	0.2	0.0	0.1	0.4

Assembly power (het.) : 0.22020

Assembly power (1 n/ass.) : 0.21964

Assembly power (4 n/ass.) : 0.22075

Errors (1 n/ass.) Method 1: Av. 15.0% Max. 42.9% Method 2: Av. 13.5% Max.-37.8%

Errors (4 n/ass.) Method 1: Av. 3.4% Max. 17.6% Method 2: Av. 3.1% Max. 14.4%

Table 4.4.3
C4, UX assembly, lower right.

662	656	634	606	574	538	496	453	409	363	317	270	221	172	122	73	24
-19.2	-13.4	-3.5	5.0	10.4	11.1	8.5	3.5	-1.5	-1.5	-2.3	-3.1	-3.1	-2.3	0.0	2.7	6.1
-11.5	-1.2	4.6	4.6	1.9	-0.4	0.0	1.5	0.8	0.4	0.4	0.0	-0.4	-1.2	-1.2	-1.2	-0.8
656	687	682	661	633	599	548	500	456	401	350	301	245	189	134	80	26
-13.4	-6.5	2.3	8.8	11.5	11.5	9.6	6.1	0.4	0.4	-0.8	-1.5	-1.9	-1.5	0.4	2.7	6.9
-1.2	6.1	8.8	6.5	2.7	0.0	0.4	3.5	3.5	2.3	2.3	1.9	0.8	0.0	-0.8	-1.2	-0.4
634	682	692	684	657	0	565	515	0	413	359	0	255	197	139	82	27
-3.5	2.3	6.5	6.5	4.6	0.0	3.1	3.8	0.0	2.7	2.7	0.0	0.4	-0.4	-0.8	0.0	1.5
4.6	8.8	9.2	5.4	0.4	0.0	-2.3	1.2	0.0	3.1	3.8	0.0	1.2	0.0	-1.2	-1.2	-0.8
606	661	684	0	645	600	547	498	454	399	348	301	249	0	139	81	26
5.0	8.8	6.5	0.0	-6.5	-9.2	-7.3	-1.9	2.3	3.8	4.2	3.8	2.7	0.0	-2.3	-3.5	-3.8
4.6	6.5	5.4	0.0	-4.6	-7.3	-6.5	-2.7	0.8	2.7	2.7	2.3	1.5	0.0	-1.5	-1.5	-0.8
574	633	657	645	609	571	521	474	432	380	331	286	235	186	133	78	25
10.4	11.5	4.6	-6.5	-15.7	-19.6	-16.1	-7.3	1.2	3.8	5.0	4.6	3.1	0.4	-2.7	-5.8	-7.7
1.9	2.7	0.4	-4.6	-9.2	-11.5	-10.4	-6.1	-1.2	1.5	1.9	1.5	0.8	-0.4	-1.5	-1.5	-0.8
538	599	0	600	571	0	494	449	0	361	313	0	221	172	0	75	24
11.1	11.5	0.0	-9.2	-19.6	0.0	-20.7	-10.8	0.0	1.9	3.8	0.0	2.3	0.8	0.0	-5.8	-7.7
-0.4	0.0	0.0	-7.3	-11.5	0.0	-12.7	-8.1	0.0	0.0	1.2	0.0	0.0	-0.4	0.0	-2.3	-0.8
496	548	565	547	521	494	452	412	375	330	287	247	201	157	114	68	22
8.5	9.6	3.1	-7.3	-16.1	-20.7	-18.1	-10.0	-1.2	0.8	2.3	2.3	1.5	0.4	-1.5	-3.5	-3.8
0.0	0.4	-2.3	-6.5	-10.4	-12.7	-11.1	-7.7	-2.3	0.4	0.8	0.8	0.0	-0.4	-1.5	-1.5	-0.8
453	500	515	498	474	449	412	375	342	301	262	225	183	142	103	62	20
3.5	6.1	3.8	-1.9	-7.3	-10.8	-10.0	-5.4	-1.2	0.4	0.8	0.8	0.4	0.4	0.0	0.0	1.2
1.5	3.5	1.2	-2.7	-6.1	-8.1	-7.7	-3.8	-0.8	1.5	1.5	1.5	0.8	0.4	-0.4	-1.2	-0.8
409	456	0	454	432	0	375	342	0	275	238	0	167	129	0	56	18
-1.5	0.4	0.0	2.3	1.2	0.0	-1.2	-1.2	0.0	0.0	-0.4	0.0	-4.6	-5.4	0.0	3.1	18.4
0.8	3.5	0.0	0.8	-1.2	0.0	-2.3	-0.8	0.0	1.5	2.3	0.0	1.2	0.8	0.0	-0.4	-0.4
363	401	413	399	380	361	330	301	275	241	210	180	147	114	83	49	16
-1.5	0.4	2.7	3.8	3.8	1.9	0.8	0.4	0.0	-3.5	-7.3	-10.8	-11.9	-9.6	-2.3	12.3	36.9
0.4	2.3	3.1	2.7	1.5	0.0	0.4	1.5	1.5	1.9	1.5	1.5	0.8	0.8	0.0	0.0	0.0
317	350	359	348	331	313	287	262	238	210	182	157	128	99	72	43	14
-2.3	-0.8	2.7	4.2	5.0	3.8	2.3	0.8	0.4	-2.7	-5.8	-8.1	-7.7	-4.6	0.8	10.0	22.3
0.4	2.3	3.8	2.7	1.9	1.2	0.8	1.5	2.3	1.5	1.5	1.2	0.8	0.8	0.0	-0.4	-0.4
270	301	0	301	286	0	247	225	0	180	157	0	110	85	0	37	12
-3.1	-1.5	0.0	3.8	4.6	0.0	2.3	0.8	0.0	-0.4	-1.2	0.0	-1.2	0.8	0.0	3.5	3.1
0.0	1.9	0.0	2.3	1.5	0.0	0.8	1.5	0.0	1.5	1.2	0.0	0.8	0.8	0.0	-0.4	-0.4
221	245	255	249	235	221	201	183	167	147	128	110	90	71	51	30	10
-3.1	-1.9	0.4	2.7	3.1	2.3	1.5	0.4	-0.4	1.9	2.7	3.5	4.2	4.2	2.7	-2.3	-12.3
-0.4	0.8	1.2	1.5	0.8	0.0	0.0	0.8	1.2	0.8	0.8	0.8	0.4	0.4	-0.4	-0.4	-0.4
172	189	197	0	186	172	157	142	129	114	99	85	71	0	40	23	7
-2.3	-1.5	-0.4	0.0	0.4	0.8	0.4	0.4	0.4	3.1	5.0	6.5	6.9	0.0	1.9	-5.8	-19.6
-1.2	0.0	0.0	0.0	-0.4	-0.4	-0.4	0.4	0.8	0.8	0.8	0.8	0.4	0.0	-0.4	-0.4	0.0
122	134	139	139	133	0	114	103	0	83	72	0	51	40	28	16	5
0.0	0.4	-0.8	-2.3	-2.7	0.0	-1.5	0.0	0.0	2.7	4.6	0.0	6.5	5.0	1.2	-6.1	-19.2
-1.2	-0.8	-1.2	-1.5	-1.5	0.0	-1.5	-0.4	0.0	0.0	0.0	0.0	-0.4	-0.4	-0.4	0.0	0.0
73	80	82	81	78	75	68	62	56	49	43	37	30	23	16	9	3
2.7	2.7	0.0	-3.5	-5.8	-5.8	-3.5	0.0	1.5	2.3	3.5	5.0	5.0	3.5	0.0	-5.8	-14.2
-1.2	-1.2	-1.2	-1.5	-1.5	-2.3	-1.5	-1.2	-0.4	0.0	-0.4	-0.4	-0.4	-0.4	0.0	0.0	0.0
24	26	27	26	25	24	22	20	18	16	14	12	10	7	5	3	1
6.1	6.9	1.5	-3.8	-7.7	-7.7	-3.8	1.2	3.5	3.8	5.4	6.5	5.4	2.3	-3.1	-8.8	0.0
-0.8	-0.4	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.4	0.0	-0.4	-0.4	-0.4	0.0	0.0	0.0	0.0

Assembly power (het.) : 0.06847

Assembly power (1 n/ass.) : 0.06879

Assembly power (4 n/ass.) : 0.06834

Errors (1 n/ass.) Method 1: Av. 42.2% Max.174.8% Method 2: Av. 9.9% Max. 42.6%

Errors (4 n/ass.) Method 1: Av. 4.8% Max. 36.9% Method 2: Av. 1.9% Max.-12.7%

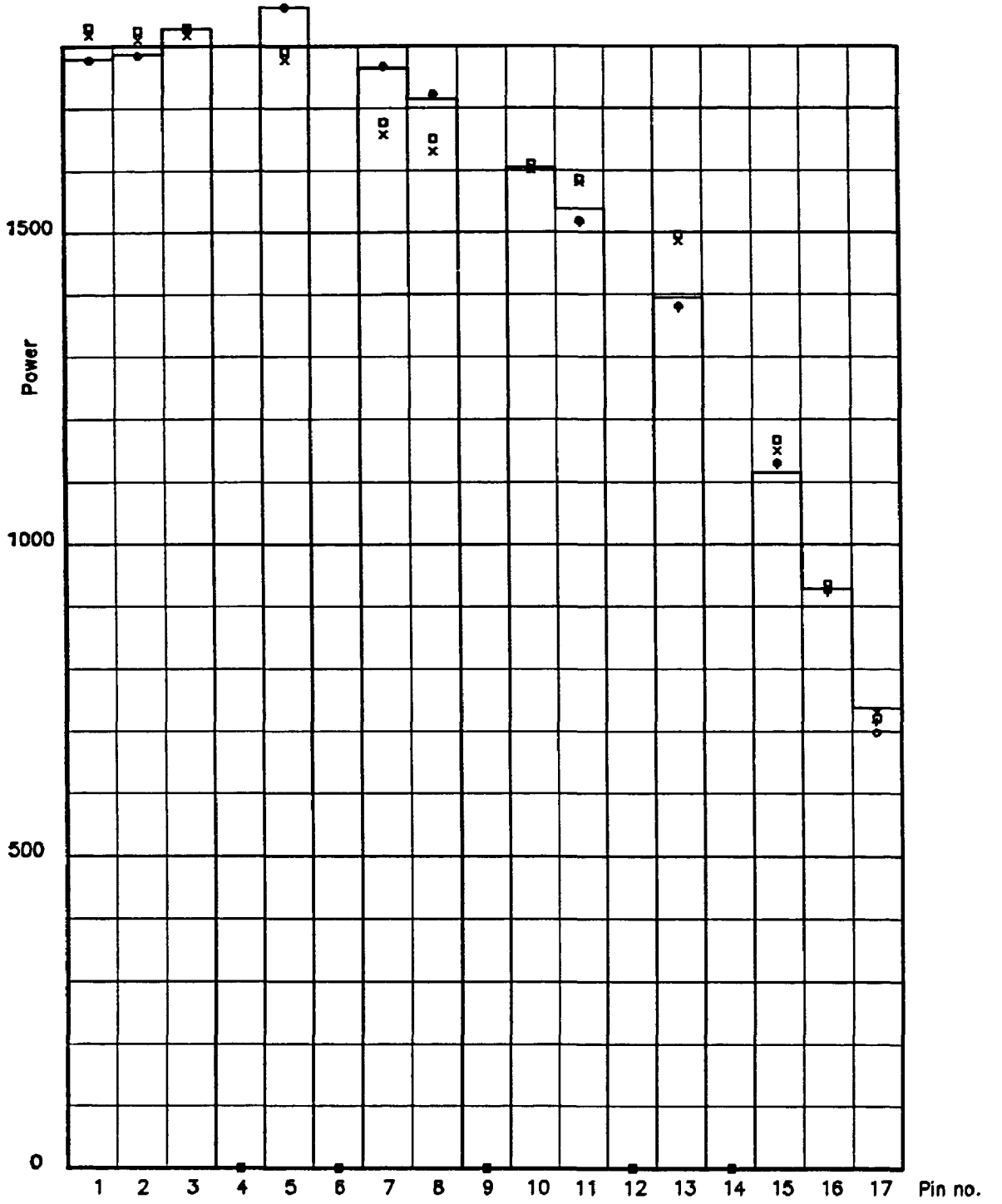


Figure 4.4.1

C4, UX ASSEMBLY

Diagonal power traverse

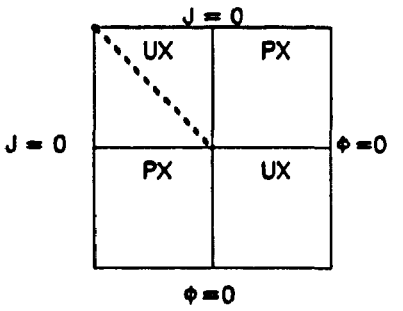
——— 'Heterogeneous' calc.

× Method 1, 1 node /ass.

\+ Method 1, 4 nodes/ass.

□ Method 2, 1 node /ass.

◇ Method 2, 4 nodes/ass.



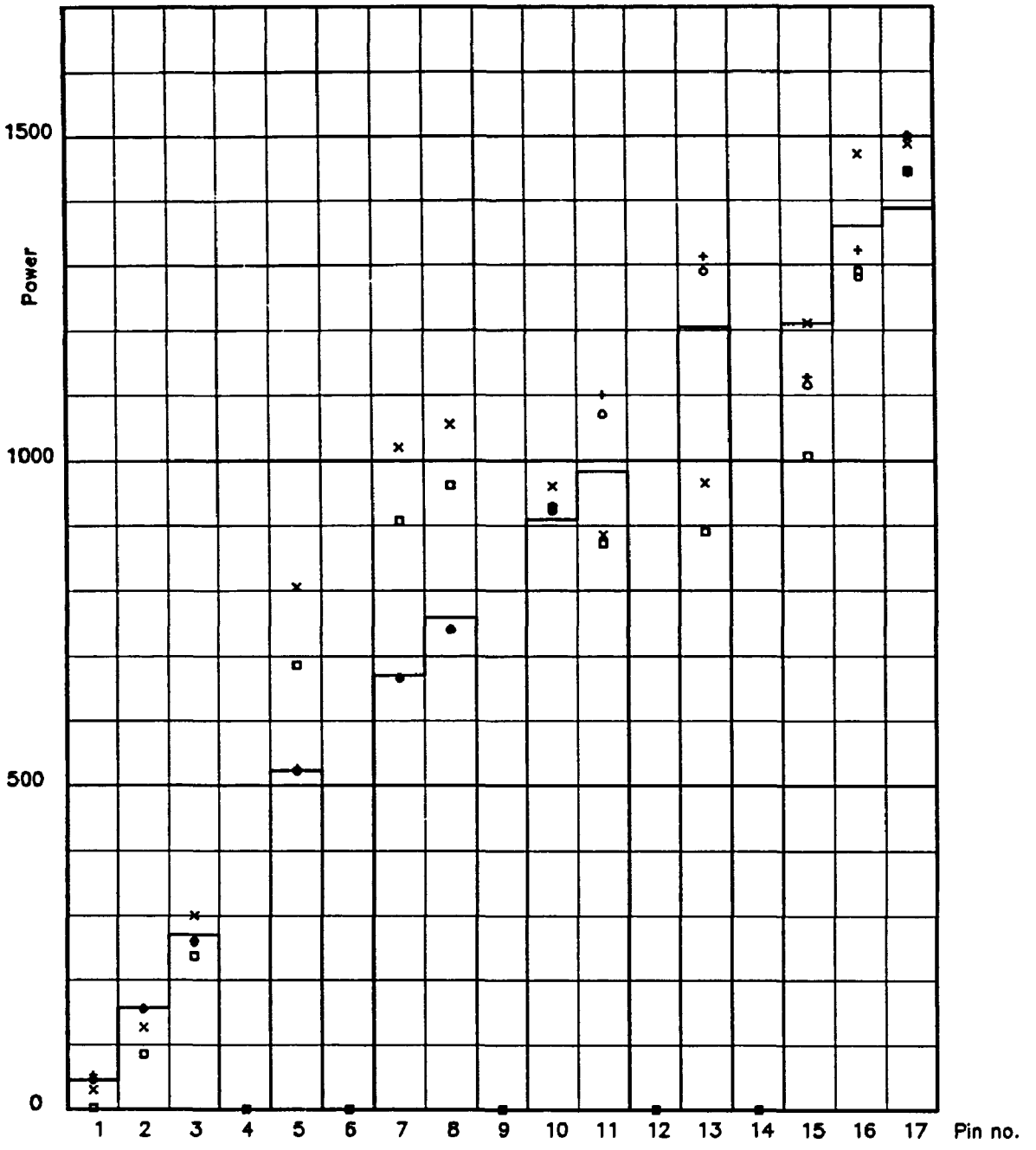


Figure 4.4.2

C4, PX assembly

Diagonal power traverse

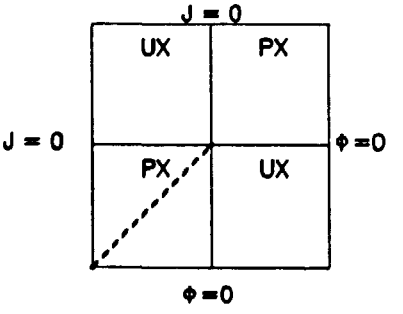
—— 'Heterogeneous' calc.

× Method 1, 1 node /ass.

+ Method 1, 4 nodes/ass.

□ Method 2, 1 node /ass.

○ Method 2, 4 nodes/ass.



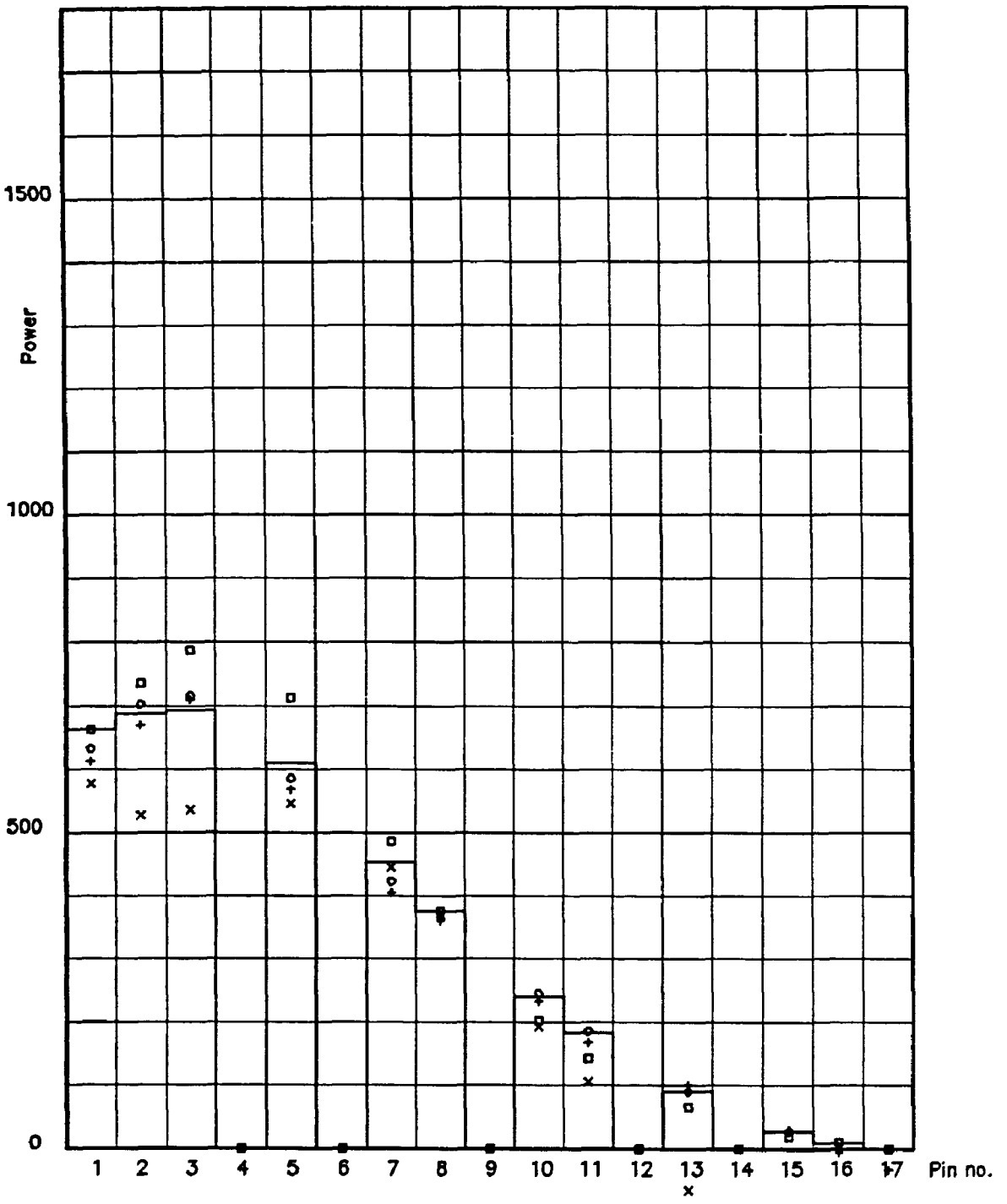


Figure 4.4.3

C4, UX ASSEMBLY

Diagonal power traverse

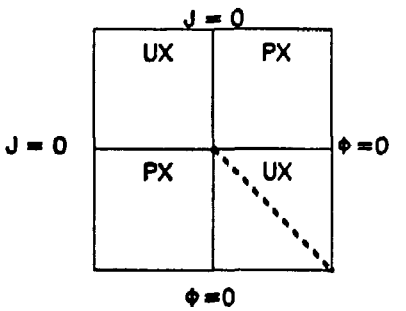
——— 'Heterogeneous' calc.

× Method 1, 1 node /ass.

\+ Method 1, 4 nodes/ass.

□ Method 2, 1 node /ass.

o Method 2, 4 nodes/ass.



4.4.2 C4V: Vacuum Boundary

k_{eff} (1 node/pin) = 0.91758
k_{eff} (1 node/assembly) = 0.91837
k_{eff} (4 nodes/assembly) = 0.91838

Assembly Powers:

J = 0

	UX 0.37157 0.37414 0.37181	**PX** 0.23195 0.23090 0.23235
J = 0		Vacuum (J_{in} = 0)
	PX 0.23195 0.23090 0.23235	**UX** 0.08159 0.08191 0.08131

Vacuum (J_{in} = 0)

Table 4.4.4
C4V, UX assembly, upper left.

1629	1632	1636	1641	1643	1639	1623	1605	1586	1560	1531	1498	1451	1390	1310	1199	1026
0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.4	0.2	-0.2	-0.4	-0.1	0.4	0.6	0.1	-0.7
0.1	0.0	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.3	-0.2	-0.4	-0.1	0.3	0.6	0.1	-0.8
1632	1637	1648	1659	1673	1681	1650	1631	1624	1585	1556	1537	1477	1406	1319	1202	1026
0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.5	0.3	-0.2	-0.4	-0.1	0.3	0.6	0.2	-0.6
0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.6	0.3	-0.2	-0.4	-0.1	0.3	0.6	0.1	-0.7
1636	1648	1675	1708	1722	0	1681	1660	0	1613	1585	0	1520	1447	1342	1209	1027
0.1	0.1	0.1	0.2	0.1	0.0	0.3	0.4	0.0	0.4	-0.2	0.0	-0.2	0.3	0.5	0.2	-0.6
0.1	0.1	0.1	0.2	0.1	0.0	0.2	0.3	0.0	0.3	-0.2	0.0	-0.1	0.4	0.5	0.2	-0.6
1641	1659	1708	0	1733	1709	1667	1644	1639	1597	1571	1561	1529	0	1369	1218	1029
0.1	0.1	0.2	0.0	0.1	0.1	0.2	0.4	0.6	0.4	-0.1	-0.4	-0.2	0.0	0.4	0.1	-0.6
0.1	0.1	0.2	0.0	0.2	0.2	0.2	0.4	0.4	0.4	-0.2	-0.4	-0.1	0.0	0.5	0.1	-0.5
1643	1673	1722	1733	1712	1701	1660	1638	1632	1591	1564	1553	1510	1466	1378	1228	1030
0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.6	0.4	-0.1	-0.4	-0.1	0.4	0.6	0.1	-0.5
0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.5	0.4	-0.1	-0.4	-0.1	0.4	0.6	0.1	-0.5
1639	1681	0	1709	1701	0	1665	1644	0	1597	1568	0	1500	1444	0	1234	1027
0.1	0.2	0.0	0.1	0.2	0.0	0.3	0.4	0.0	0.4	-0.1	0.0	-0.1	0.5	0.0	0.2	-0.5
0.1	0.2	0.0	0.2	0.2	0.0	0.3	0.4	0.0	0.3	-0.1	0.0	-0.1	0.5	0.0	0.1	-0.5
1623	1650	1681	1667	1660	1665	1631	1611	1606	1565	1537	1520	1463	1408	1343	1209	1016
0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.4	0.5	0.4	-0.1	-0.3	0.1	0.6	0.7	0.3	-0.4
0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.5	0.4	-0.1	-0.3	0.0	0.5	0.7	0.3	-0.4
1605	1631	1660	1644	1638	1644	1611	1592	1587	1547	1518	1500	1443	1388	1325	1194	1003
0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	-0.1	-0.1	0.2	0.7	0.8	0.4	-0.2
0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.6	0.4	-0.1	-0.2	0.1	0.6	0.8	0.4	-0.2
1586	1624	0	1639	1632	0	1606	1587	0	1542	1512	0	1438	1382	0	1189	991
0.4	0.5	0.0	0.6	0.6	0.0	0.5	0.4	0.0	0.2	0.1	0.0	0.3	0.8	0.0	0.3	-0.3
0.4	0.6	0.0	0.4	0.5	0.0	0.5	0.6	0.0	0.2	-0.3	0.0	-0.1	0.6	0.0	0.8	0.1
1560	1585	1613	1597	1591	1597	1565	1547	1542	1502	1473	1456	1401	1347	1285	1158	973
0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.2	-0.3	-0.9	-1.0	-0.5	0.4	1.1	0.9	0.1
0.3	0.3	0.3	0.4	0.4	0.3	0.4	0.4	0.2	-0.2	-0.8	-1.1	-0.6	0.2	0.9	1.0	0.4
1531	1556	1585	1571	1564	1568	1537	1518	1512	1473	1446	1430	1376	1323	1262	1137	955
-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	0.1	-0.9	-1.8	-2.1	-1.3	-0.2	0.7	0.8	0.1
-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.3	-0.8	-1.4	-1.7	-1.2	-0.3	0.4	0.4	0.1
1498	1537	0	1561	1553	0	1520	1500	0	1456	1430	0	1366	1314	0	1124	935
-0.4	-0.4	0.0	-0.4	-0.4	0.0	-0.3	-0.1	0.0	-1.0	-2.1	0.0	-1.8	-0.5	0.0	0.6	-0.1
-0.4	-0.4	0.0	-0.4	-0.4	0.0	-0.3	-0.2	0.0	-1.1	-1.7	0.0	-1.5	-0.6	0.0	0.1	-0.1
1451	1477	1520	1529	1510	1500	1463	1443	1438	1401	1376	1366	1327	1288	1212	1081	908
-0.1	-0.1	-0.2	-0.2	-0.1	-0.1	0.1	0.2	0.3	-0.5	-1.3	-1.8	-1.3	-0.3	0.5	0.6	-0.2
-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1	-0.1	-0.6	-1.2	-1.5	-1.0	-0.3	0.3	0.4	-0.1
1390	1406	1447	0	1466	1444	1408	1388	1382	1347	1323	1314	1288	0	1157	1032	874
0.4	0.3	0.3	0.0	0.4	0.5	0.6	0.7	0.8	0.4	-0.2	-0.5	-0.3	0.0	0.7	0.6	-0.2
0.3	0.3	0.4	0.0	0.4	0.5	0.5	0.6	0.6	0.2	-0.3	-0.6	-0.3	0.0	0.6	0.6	0.1
1310	1319	1342	1369	1378	0	1343	1325	0	1285	1262	0	1212	1157	1076	975	835
0.6	0.6	0.5	0.4	0.6	0.0	0.7	0.8	0.0	1.1	0.7	0.0	0.5	0.7	0.8	0.4	-0.4
0.6	0.6	0.5	0.5	0.6	0.0	0.7	0.8	0.0	0.9	0.4	0.0	0.3	0.6	1.0	0.7	-0.1
1199	1202	1209	1218	1228	1234	1209	1194	1189	1158	1137	1124	1081	1032	975	901	790
0.1	0.2	0.2	0.1	0.1	0.2	0.3	0.4	0.3	0.9	0.8	0.6	0.6	0.6	0.4	-0.3	-1.1
0.1	0.1	0.2	0.1	0.1	0.1	0.3	0.4	0.8	1.0	0.4	0.1	0.4	0.6	0.7	0.1	-1.3
1026	1026	1027	1029	1030	1027	1016	1003	991	973	955	935	908	874	835	790	725
-0.7	-0.6	-0.6	-0.6	-0.5	-0.5	-0.4	-0.2	-0.3	0.1	0.1	-0.1	-0.2	-0.2	-0.4	-1.1	-1.6
-0.8	-0.7	-0.6	-0.5	-0.5	-0.5	-0.4	-0.2	0.1	0.4	0.1	-0.1	-0.1	0.1	-0.1	-1.3	-2.8

Assembly power (het.) : 0.37157

Assembly power (1 n/ass.) : 0.37414

Assembly power (4 n/ass.) : 0.37181

Errors (1 n/ass.) Method 1: Av. 2.5% Max. -7.3% Method 2: Av. 2.3% Max. 7.0%

Errors (4 n/ass.) Method 1: Av. 0.4% Max. -2.1% Method 2: Av. 0.4% Max. -2.8%

Table 4.4.5
C4V, PX assembly.

1719	1708	1700	1701	1704	1699	1680	1659	1639	1609	1579	1548	1503	1451	1401	1365	1371
7.9	6.0	4.9	4.4	4.7	5.2	5.5	6.1	6.7	4.2	2.7	2.0	1.6	1.7	3.1	5.6	6.5
7.4	6.3	5.8	5.7	5.7	5.7	4.9	4.4	3.4	1.9	4.6	6.1	4.0	-0.2	-1.9	3.2	12.6
1385	1607	1592	1601	1628	1659	1596	1573	1591	1526	1499	1511	1439	1373	1333	1345	1230
-3.2	-6.0	-6.3	-6.3	-6.0	-5.5	-5.5	-4.8	-4.0	-7.4	-7.7	-7.4	-8.2	-8.8	-7.7	-4.0	2.2
-3.5	-5.8	-5.5	-5.2	-5.0	-4.9	-5.8	-6.3	-8.5	-8.3	-4.3	-2.0	-4.3	-8.5	-11.4	-9.1	1.8
1220	1404	1417	1469	1489	0	1409	1383	0	1342	1322	0	1317	1265	1202	1214	1162
-5.3	-6.7	-6.5	-6.4	-7.1	0.0	-7.7	-7.6	0.0	-8.9	-6.7	0.0	-6.3	-8.2	-9.6	-7.1	1.5
-5.6	-6.7	-6.3	-6.1	-6.7	0.0	-7.6	-8.0	0.0	-7.5	-3.6	0.0	-3.5	-7.1	-10.7	-10.8	-3.2
1129	1306	1363	0	1356	1480	1377	1349	1376	1308	1292	1345	1197	0	1163	1147	1105
-1.5	-1.5	-1.1	0.0	-1.8	-3.2	-3.4	-4.3	-6.4	-3.4	1.5	4.0	2.3	0.0	-6.7	-5.9	3.4
-1.5	-1.6	-1.5	0.0	-2.3	-3.3	-3.2	-3.5	-4.6	-1.3	2.5	4.1	2.3	0.0	-5.8	-6.5	-0.5
1064	1251	1297	1277	1370	1331	1244	1219	1244	1182	1167	1210	1209	1100	1108	1104	1054
3.8	5.1	5.7	5.1	5.3	5.1	3.8	2.4	0.5	5.1	11.5	15.1	12.2	4.3	-2.0	-3.4	5.1
4.0	4.9	5.0	4.1	4.4	4.7	4.2	3.9	3.8	6.6	10.0	12.0	9.6	4.2	0.3	-0.6	4.6
1005	1210	0	1312	1261	0	1197	1175	0	1140	1121	0	1114	1130	0	1068	998
6.0	8.0	0.0	8.9	8.7	0.0	6.9	5.5	0.0	9.2	16.6	0.0	16.0	8.2	0.0	-2.7	5.2
6.4	7.7	0.0	7.9	7.7	0.0	7.3	6.8	0.0	9.6	13.3	0.0	12.2	7.7	0.0	2.3	7.2
936	1095	1094	1154	1113	1133	1072	1054	1080	1022	1004	1029	982	993	934	968	931
4.2	5.2	5.2	5.6	5.6	5.2	4.6	3.8	2.2	7.4	13.3	15.8	12.2	5.2	-2.2	-4.2	3.3
4.6	5.1	4.8	5.1	5.0	5.0	4.7	4.4	4.0	6.8	10.0	11.4	9.1	5.2	1.0	0.3	5.6
868	1012	1004	1058	1022	1040	988	973	994	943	926	944	901	909	856	894	863
0.0	0.0	0.2	0.1	0.2	0.3	0.1	0.0	-0.7	2.4	6.3	7.7	4.8	-0.2	-4.8	-5.5	1.4
0.0	0.1	0.2	0.1	0.2	0.3	0.1	-0.1	-0.7	1.6	4.6	5.8	4.0	0.6	-2.7	-3.6	2.2
802	959	0	1008	976	0	946	931	0	903	885	0	860	865	0	845	795
-2.4	-3.1	0.0	-3.5	-3.2	0.0	-3.0	-2.8	0.0	-2.5	-0.9	0.0	-2.2	-4.1	0.0	-2.8	2.0
-2.5	-3.0	0.0	-3.3	-3.1	0.0	-3.2	-3.1	0.0	-2.3	0.3	0.0	-0.1	-3.2	0.0	-5.6	0.0
729	851	847	890	860	878	832	820	840	794	779	796	757	763	721	750	722
-1.6	-1.9	-2.2	-2.0	-1.9	-2.2	-1.9	-2.0	-2.8	-1.9	-1.0	-1.3	-2.0	-3.3	-3.6	-1.7	2.0
-1.0	-1.9	-2.3	-2.3	-2.2	-2.4	-2.2	-2.0	-1.8	-1.8	0.0	0.6	-0.5	-2.8	-4.9	-4.3	0.6
656	764	760	802	773	785	746	734	749	711	698	712	680	687	645	672	649
-1.3	-1.0	-0.8	-0.8	-0.7	-0.6	-0.9	-1.0	-1.5	-1.3	-0.6	-0.5	-1.4	-2.4	-2.2	-0.7	1.8
-0.6	-1.0	-1.0	-1.1	-0.9	-0.8	-1.1	-1.0	-0.6	-1.0	0.6	1.5	0.2	-1.9	-3.5	-3.4	0.5
584	701	0	753	725	0	691	679	0	658	646	0	637	645	0	615	575
-1.4	-1.3	0.0	-0.6	-0.6	0.0	-0.9	-1.3	0.0	-1.5	-0.7	0.0	-1.1	-1.9	0.0	-0.8	1.4
-0.6	-1.1	0.0	-0.9	-0.9	0.0	-1.1	-1.1	0.0	-1.3	0.3	0.0	0.2	-1.8	0.0	-3.2	0.5
505	595	615	596	640	627	585	574	587	555	547	567	561	509	521	521	496
-1.3	-1.5	-1.3	-0.3	-0.5	-0.8	-0.8	-1.1	-1.8	-1.1	-0.3	-0.2	-0.3	-1.0	-2.0	-1.3	0.8
-0.6	-1.4	-1.4	-0.7	-0.8	-1.1	-1.0	-1.0	-0.8	-0.9	0.3	0.9	0.5	-1.1	-3.3	-2.8	0.6
423	490	511	0	499	538	502	490	497	475	469	486	437	0	433	428	414
-0.9	-1.0	-0.9	0.0	0.0	0.5	0.1	0.1	-0.2	0.1	1.1	1.9	0.8	0.0	-1.9	-1.5	0.3
-0.3	-1.0	-1.0	0.0	-0.3	0.1	0.0	0.2	0.9	0.2	1.3	2.0	0.8	0.0	-2.5	-2.0	0.9
340	391	398	415	415	0	384	376	0	364	358	0	364	354	336	340	331
-0.2	-0.3	-0.7	-0.9	-0.5	0.0	0.2	0.1	0.0	0.5	1.9	0.0	1.5	-0.5	-1.9	-2.0	0.0
0.0	-0.5	-0.8	-1.0	-0.6	0.0	0.1	0.2	0.0	0.5	1.3	0.0	0.5	-1.0	-1.7	-1.1	1.4
254	291	290	293	299	306	290	284	290	275	271	277	262	250	244	252	246
0.5	0.3	0.0	-0.3	-0.5	-0.6	-0.1	0.0	-0.7	0.5	2.5	3.4	2.7	0.5	-2.0	-3.3	-0.7
0.0	0.1	0.0	-0.1	-0.2	-0.3	0.0	0.0	-0.6	0.3	0.9	0.9	0.7	-0.1	-0.6	-0.2	1.3
158	156	155	155	156	156	153	150	149	145	143	141	137	132	129	132	148
0.7	0.3	-0.1	-0.3	-0.6	-0.6	-0.3	-0.2	-0.8	0.6	2.8	4.2	3.4	0.6	-2.8	-4.9	-2.2
-2.2	0.2	0.7	0.7	0.6	0.6	0.6	-0.5	-5.2	-0.2	1.1	1.3	1.0	0.8	0.6	0.5	-1.4

Assembly power (het.) : 0.23195

Assembly power (1 n/ass.) : 0.23090

Assembly power (4 n/ass.) : 0.23235

Errors (1 n/ass.) Method 1: Av. 14.8% Max. 42.0% Method 2: Av. 13.3% Max.-36.8%

Errors (4 n/ass.) Method 1: Av. 3.2% Max. 16,6% Method 2: Av. 3.0% Max. 13.3%

Table 4.4.6
CAV, UX assembly, lower right.

639	658	641	617	591	559	523	485	447	406	364	323	278	233	185	136	82
-15.2	-10.7	-2.9	3.9	7.4	8.4	6.1	2.6	-1.6	-1.6	-2.3	-2.9	-2.6	-1.9	0.0	1.9	4.5
-10.0	-1.6	3.2	3.6	1.3	0.0	0.0	1.3	0.6	1.0	1.0	0.3	0.0	-0.6	-0.6	-1.6	-3.9
658	694	694	678	655	627	581	539	500	451	404	361	310	257	204	148	88
-10.7	-5.2	1.9	6.0	9.1	9.1	7.0	4.9	0.3	0.0	-0.6	-1.6	-1.9	-1.0	0.3	2.6	5.5
-1.6	4.5	6.0	5.2	2.3	0.0	0.6	2.9	3.2	1.9	1.9	1.3	0.3	-0.3	-1.0	-1.0	-0.3
641	694	709	706	685	0	603	558	0	467	419	0	324	269	211	151	89
-2.9	1.9	5.2	5.2	3.6	0.0	2.3	3.2	0.0	1.9	1.6	0.0	0.0	-0.3	-0.3	0.3	1.3
3.2	6.8	7.4	4.2	0.3	0.0	-1.6	1.3	0.0	2.3	2.3	0.0	0.6	0.0	-0.6	-0.6	0.3
617	678	706	0	678	638	588	544	505	455	408	366	319	0	211	150	87
3.9	6.8	5.2	0.0	-5.5	-7.8	-5.8	-1.6	1.9	2.9	3.2	2.6	1.6	0.0	-1.3	-2.9	-3.6
3.6	5.2	4.2	0.0	-4.2	-6.5	-5.5	-2.3	1.0	1.3	1.6	1.3	0.6	0.0	-1.0	-1.0	0.3
591	655	685	678	646	612	565	523	485	437	392	351	304	257	204	146	84
7.4	9.1	3.6	-5.5	-12.9	-15.9	-12.9	-6.1	1.0	2.6	3.2	2.9	1.9	0.3	-2.3	-4.9	-6.0
1.3	2.3	0.3	-4.2	-7.0	-9.7	-0.7	-5.5	-1.3	0.0	0.3	0.0	-0.3	-1.0	-1.3	-1.6	0.0
559	627	0	638	612	0	541	500	0	419	375	0	288	261	0	160	80
8.4	9.1	0.0	-7.8	-15.9	0.0	-16.5	-0.7	0.0	1.8	2.3	0.0	1.3	0.0	0.0	-5.2	-6.0
0.0	0.0	0.0	-6.5	-9.7	0.0	-10.6	-6.0	0.0	-1.0	-0.6	0.8	-1.0	-1.0	0.0	-1.9	0.0
523	581	603	588	565	541	501	464	431	388	347	310	266	222	179	129	75
6.1	7.0	2.3	-5.8	-12.9	-16.5	-14.2	-8.1	-1.3	0.0	1.0	1.0	0.3	-0.3	-1.3	-2.9	-3.9
0.8	0.6	-1.6	-5.5	-8.7	-10.6	-9.6	-6.1	-2.6	-0.6	-0.3	-0.6	-2.0	-1.0	-1.3	-1.3	0.0
485	539	558	544	523	500	464	430	399	359	321	287	245	205	165	119	69
2.6	4.9	3.2	-1.6	-6.1	-8.7	-0.1	-4.9	-1.0	0.0	0.3	-0.3	0.0	0.0	0.0	0.3	1.0
1.3	2.9	1.3	-2.3	-5.5	-6.8	-6.1	-3.6	-0.6	0.6	1.0	0.6	0.3	0.0	-0.3	-0.6	-1.0
447	500	0	505	485	0	431	399	0	333	298	0	227	189	0	110	63
-1.6	0.3	0.0	1.9	1.0	0.0	-1.3	-1.0	0.0	0.6	0.6	0.0	-2.6	-4.2	0.0	0.0	13.3
0.6	3.2	0.0	1.0	-1.3	0.0	-2.6	-0.6	0.0	2.6	2.6	0.0	1.9	1.9	0.0	-0.6	-6.1
406	451	467	455	437	419	388	359	333	300	268	239	204	170	137	99	57
-1.6	0.0	1.9	2.9	2.6	1.0	0.0	0.0	0.0	-3.2	-5.5	-7.0	-0.7	-7.4	-2.9	0.4	29.0
1.0	1.9	2.3	1.3	0.0	-1.0	-0.6	0.6	2.6	1.6	1.3	1.0	1.0	1.0	0.3	-0.3	-1.0
364	404	419	408	392	375	347	321	298	268	240	214	183	152	123	88	51
-2.3	-0.6	1.6	3.2	3.2	2.3	1.0	0.3	-0.3	-2.6	-5.2	-6.5	-6.5	-3.6	0.6	0.4	19.1
1.0	1.9	2.3	1.6	0.3	-0.6	-0.3	1.0	2.6	1.3	1.0	0.6	0.3	0.6	0.0	0.0	0.0
323	361	0	366	351	0	310	287	0	239	214	0	164	136	0	79	45
-2.9	-1.6	0.0	2.6	2.9	0.0	1.0	-0.3	0.0	-0.6	-1.6	0.0	-1.6	0.6	0.0	3.6	2.9
0.3	1.3	0.0	1.3	0.0	0.0	-0.6	0.6	0.0	1.0	0.6	0.0	0.0	0.3	0.0	-0.3	0.3
278	310	324	319	304	288	266	245	227	204	183	164	141	119	95	67	39
-2.6	-1.9	0.0	1.6	1.9	1.3	0.3	0.0	-0.6	1.3	1.6	1.9	2.9	3.6	2.9	-1.0	-10.4
0.0	0.3	0.6	0.6	-0.3	-1.0	-1.0	0.3	1.9	1.0	0.3	0.0	0.0	0.0	-0.3	-0.3	0.0
233	257	269	0	257	241	222	205	189	170	152	136	119	0	79	56	32
-1.9	-1.0	-0.3	0.0	0.3	0.0	-0.3	0.0	0.3	2.6	3.9	4.9	5.2	0.0	2.6	-3.9	-16.2
-0.6	-0.3	0.0	0.0	-1.0	-1.0	-2.0	0.0	1.9	1.0	0.6	0.3	0.0	0.0	-0.6	-0.6	0.3
185	204	211	211	204	0	179	165	0	137	123	0	95	79	61	44	25
0.0	0.3	-0.3	-1.3	-2.3	0.0	-1.3	0.0	0.0	2.6	3.6	0.0	4.9	4.2	1.9	-4.2	-15.5
-0.6	-1.0	-0.6	-1.0	-1.3	0.0	-1.3	-0.3	0.0	0.3	0.0	0.0	-0.3	-0.6	-0.3	-0.3	0.3
136	148	151	150	146	140	129	119	110	99	88	79	67	56	44	32	18
1.9	2.6	0.3	-2.9	-4.9	-5.2	-2.9	0.3	1.6	1.9	2.9	3.6	3.9	2.6	0.0	-4.9	-11.0
-1.6	-1.0	-0.6	-1.0	-1.6	-1.9	-1.3	-0.6	-0.6	-0.3	0.0	-0.3	-0.3	-0.6	-0.3	-0.3	0.6
82	88	89	87	84	80	75	69	63	57	51	45	39	32	25	18	11
4.5	5.5	1.3	-3.6	-6.8	-6.8	-3.9	1.0	2.9	3.2	4.9	5.5	4.5	1.3	-3.2	-7.4	-10.4
-3.9	-0.3	0.3	0.3	0.0	0.0	0.0	-1.8	-6.1	-1.0	0.0	0.3	0.0	0.3	0.3	0.6	0.3

Assembly power (het.) : 0.08159

Assembly power (1 n/ass.) : 0.08191

Assembly power (4 n/ass.) : 0.08131

Errors (1 n/ass.) Method 1: Av. 31.1% Max.117.1% Method 2: Av. 7.9% Max. 33.0%

Errors (4 n/ass.) Method 1: Av. 3.8% Max. 29.8% Method 2: Av. 1.6% Max.-10.4%

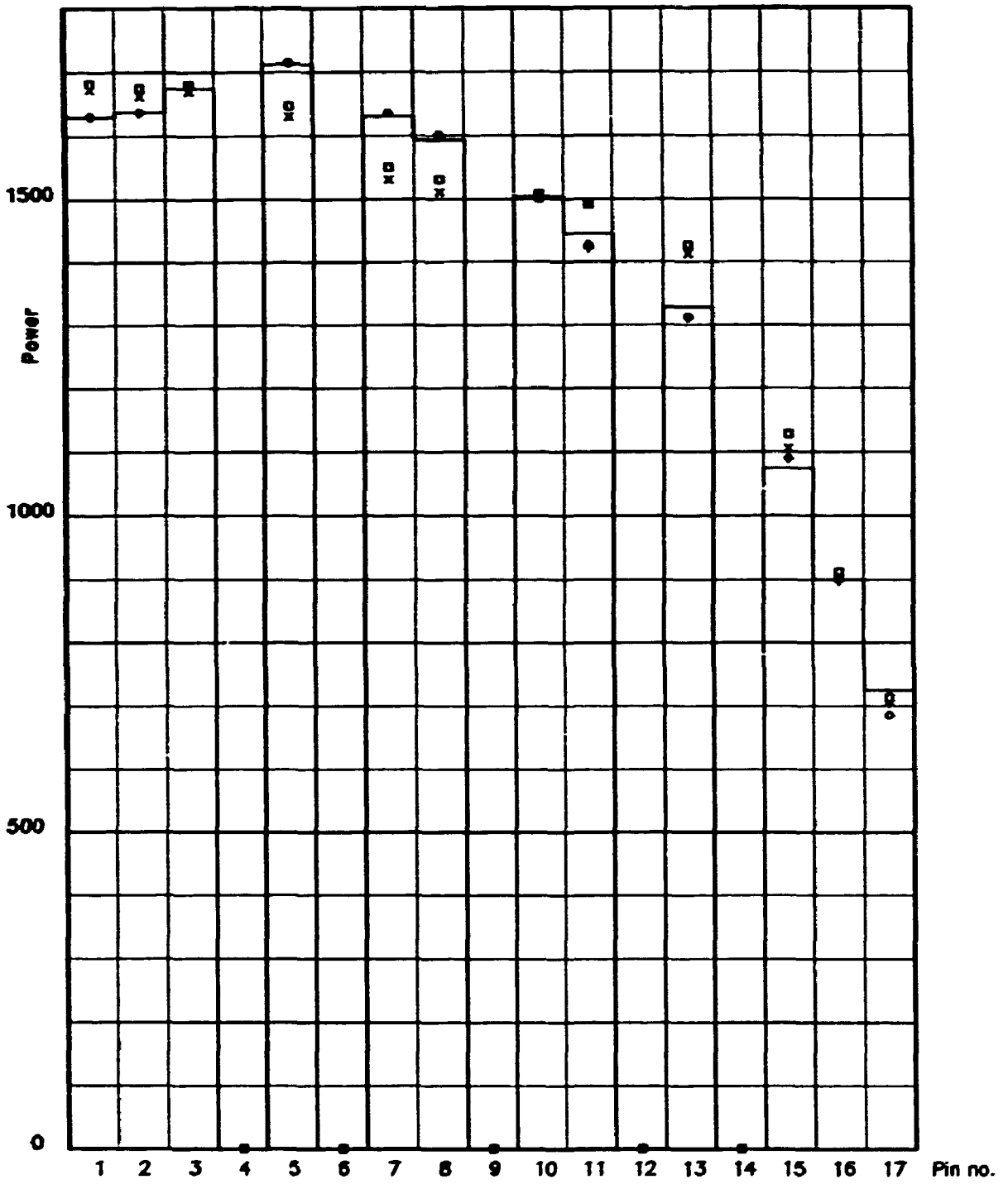


Figure 4.4.4

C4V, UX ASSEMBLY

Diagonal power traverse

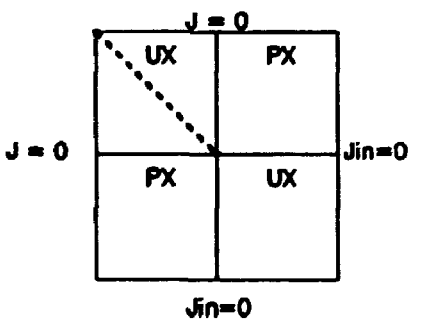
——— 'Heterogeneous' calc.

× Method 1, 1 node /ass.

+ Method 1, 4 nodes/ass.

▫ Method 2, 1 node /ass.

o Method 2, 4 nodes/ass.



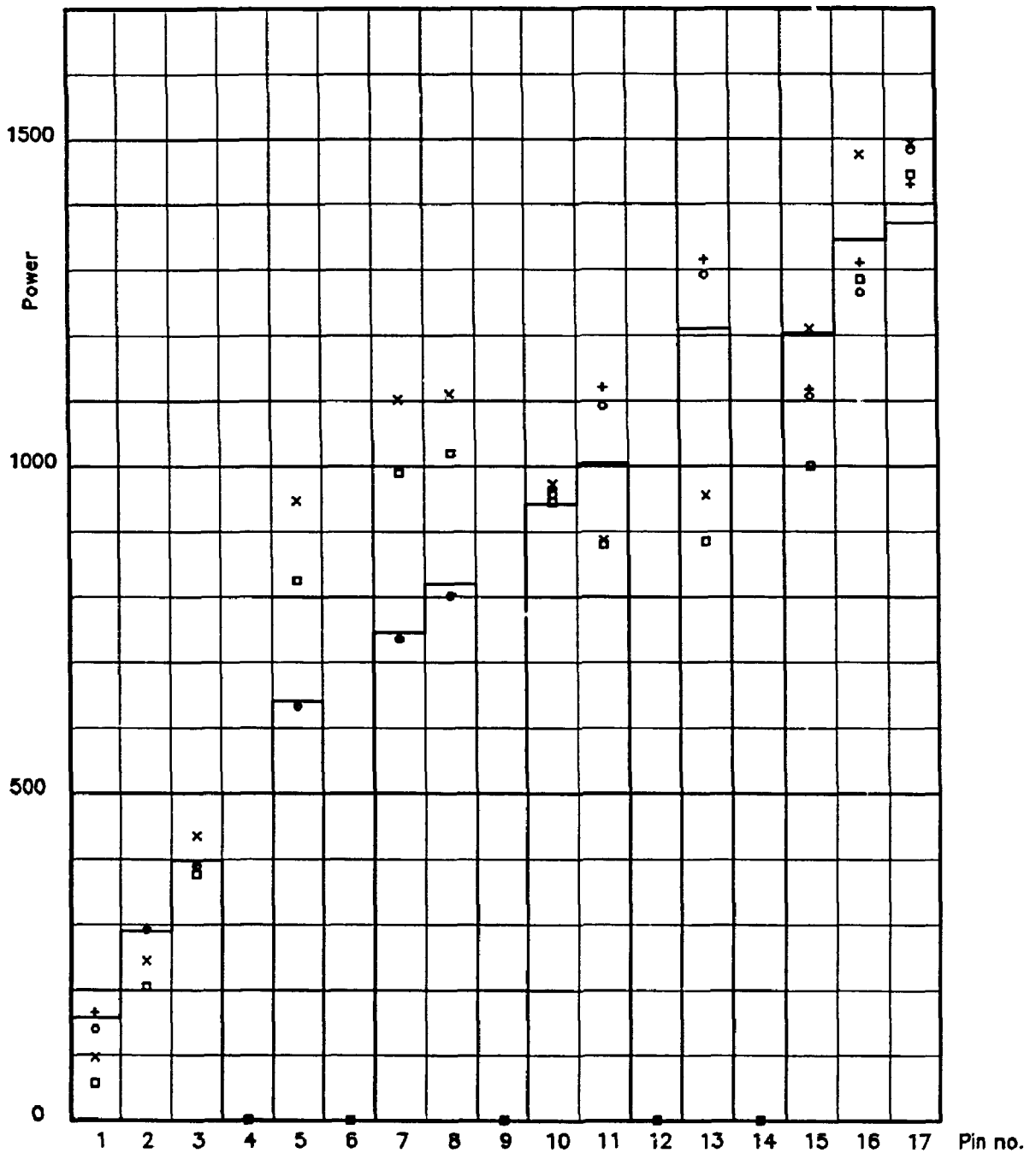


Figure 4.4.5

C4V, PX assembly

Diagonal power traverse

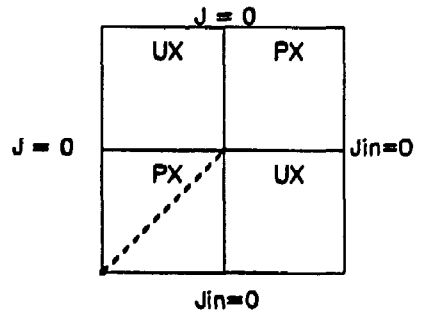
——— 'Heterogeneous' calc.

× Method 1, 1 node /ass.

\+ Method 1, 4 nodes/ass.

□ Method 2, 1 node /ass.

○ Method 2, 4 nodes/ass.



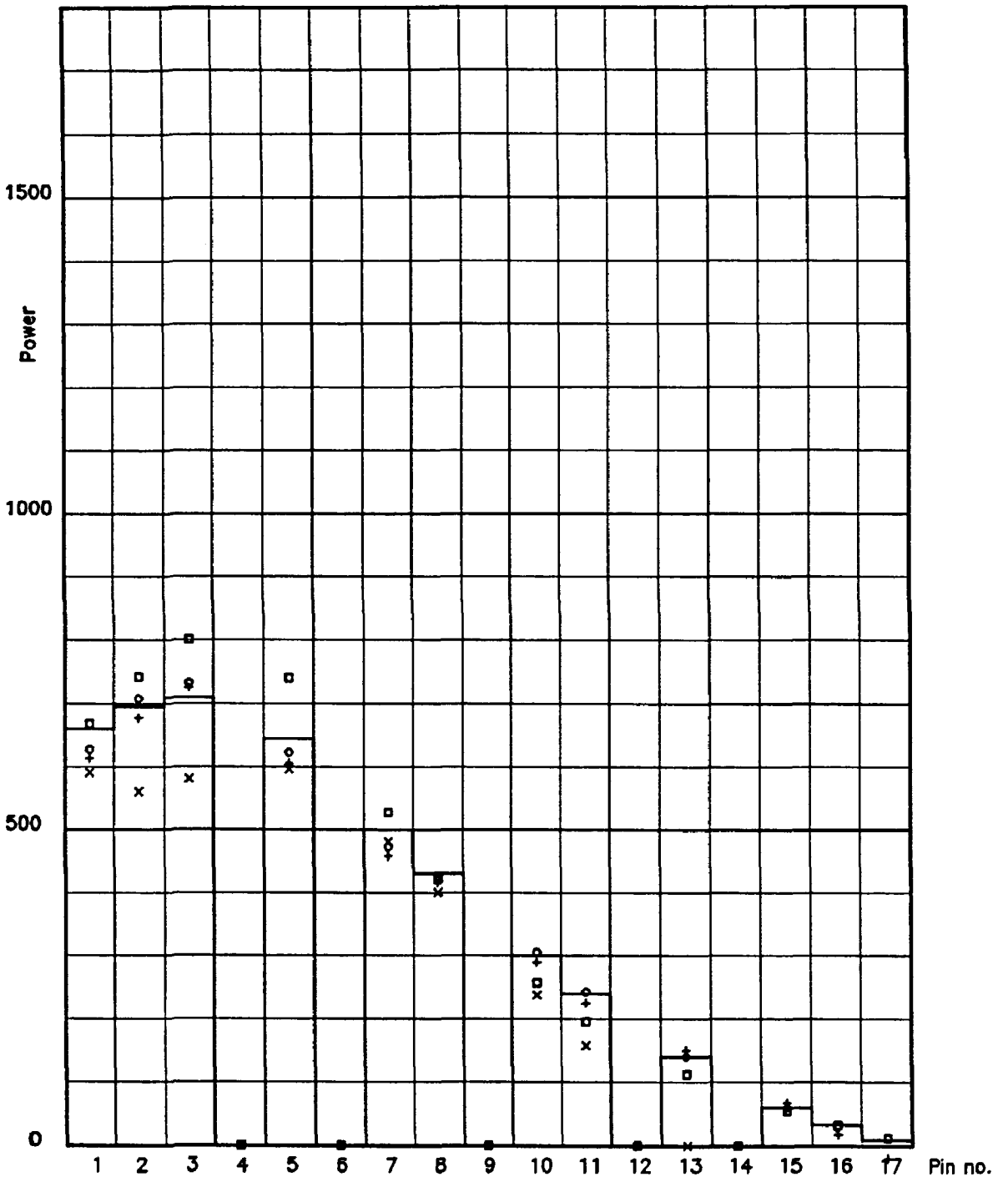
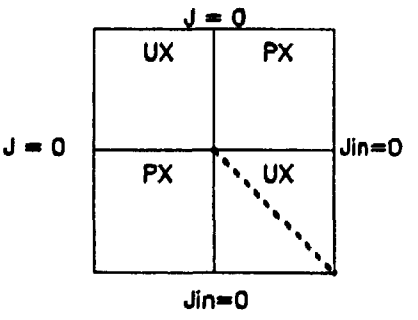


Figure 4.4.6

C4V, UX ASSEMBLY

Diagonal power traverse

- —— 'Heterogeneous' calc.
- × Method 1, 1 node /ass.
- + Method 1, 4 nodes/ass.
- □ Method 2, 1 node /ass.
- ○ Method 2, 4 nodes/ass.



4.5 C5: UX/PX/Reflector Configuration

k_{eff} (1 node/pin) = 0.93802
k_{eff} (1 node/assembly) = 0.93587
k_{eff} (4 nodes/assembly) = 0.93819

Assembly Powers:

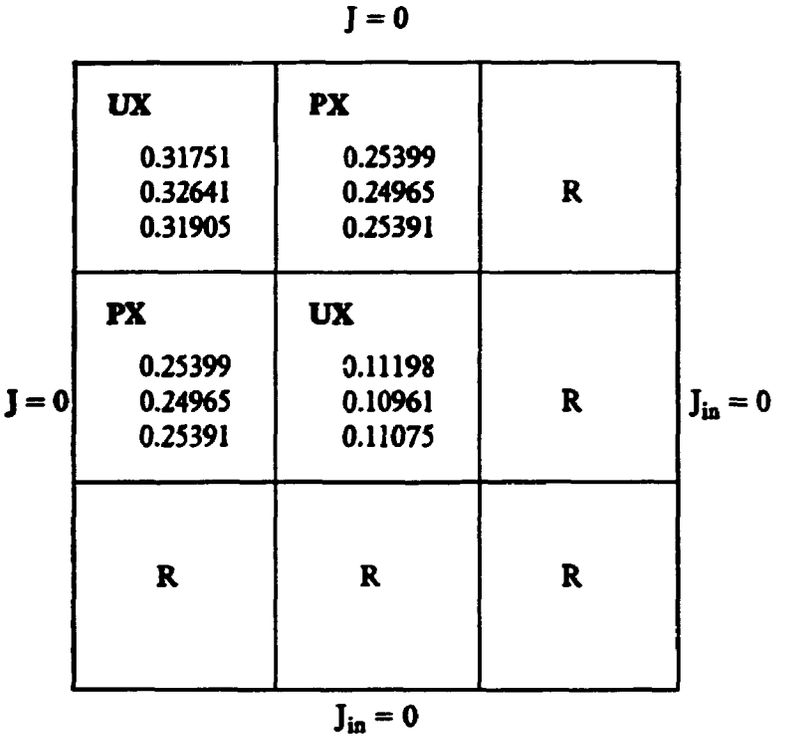


Table 4.5.1
CS, UX assembly, upper left.

1340	1342	1347	1352	1357	1356	1347	1336	1325	1308	1290	1268	1235	1190	1129	1040	897
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.9	0.7	0.2	0.2	0.4	0.8	1.0	0.5	-0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	1.0	0.8	0.2	0.1	0.3	0.7	0.9	0.5	-0.5
1342	1347	1357	1369	1382	1392	1370	1358	1358	1330	1312	1302	1259	1204	1138	1044	897
0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.9	1.0	0.8	0.2	0.1	0.2	0.7	0.9	0.5	-0.4
0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.8	1.0	0.8	0.2	0.1	0.2	0.7	0.9	0.4	-0.4
1347	1357	1381	1410	1424	0	1397	1383	0	1354	1337	0	1296	1241	1158	1051	899
0.7	0.7	0.7	0.8	0.7	0.0	0.8	1.0	0.0	0.9	0.3	0.0	0.2	0.7	0.9	0.5	-0.3
0.7	0.7	0.8	0.8	0.8	0.0	0.8	0.9	0.0	0.8	0.3	0.0	0.3	0.7	0.9	0.5	-0.3
1352	1369	1410	0	1435	1418	1387	1372	1372	1343	1327	1325	1305	0	1183	1060	902
0.7	0.7	0.8	0.0	0.8	0.8	0.8	1.0	1.2	0.9	0.3	0.0	0.2	0.0	0.8	0.5	-0.3
0.7	0.7	0.8	0.0	0.8	0.8	0.8	0.9	1.1	0.8	0.2	0.1	0.3	0.0	0.9	0.5	-0.3
1357	1382	1424	1435	1420	1414	1384	1369	1369	1340	1324	1321	1291	1261	1193	1070	904
0.7	0.7	0.7	0.8	0.8	0.8	0.8	1.0	1.2	0.9	0.3	0.0	0.3	0.7	0.9	0.5	-0.2
0.7	0.8	0.8	0.8	0.8	0.8	0.8	1.0	1.1	0.8	0.2	0.1	0.3	0.8	1.0	0.5	-0.2
1356	1392	0	1418	1414	0	1390	1377	0	1348	1330	0	1285	1244	0	1077	903
0.7	0.8	0.0	0.8	0.8	0.0	0.9	0.9	0.0	0.8	0.3	0.0	0.3	0.9	0.0	0.6	-0.2
0.7	0.8	0.0	0.8	0.8	0.0	0.9	0.9	0.0	0.7	0.3	0.0	0.3	1.0	0.0	0.6	-0.2
1347	1370	1397	1387	1384	1390	1366	1353	1354	1324	1306	1298	1257	1216	1167	1058	895
0.7	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.8	0.3	0.2	0.4	1.0	1.2	0.7	-0.1
0.7	0.7	0.8	0.8	0.8	0.9	0.8	1.0	1.0	0.8	0.3	0.2	0.4	1.0	1.2	0.7	-0.1
1336	1358	1383	1372	1369	1377	1353	1341	1342	1313	1294	1285	1243	1202	1155	1048	887
0.8	0.9	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.7	0.3	0.2	0.6	1.2	1.2	0.7	0.0
0.8	0.8	0.9	0.9	1.0	0.9	1.0	1.1	1.0	0.8	0.3	0.2	0.5	1.1	1.2	0.7	0.0
1325	1358	0	1372	1369	0	1354	1342	0	1313	1294	0	1243	1201	0	1047	878
0.9	1.0	0.0	1.2	1.2	0.0	0.9	0.9	0.0	0.7	0.3	0.0	0.7	1.2	0.0	0.5	-0.1
1.0	1.0	0.0	1.1	1.1	0.0	1.0	1.0	0.0	0.7	0.0	0.0	0.2	1.1	0.0	1.1	0.4
1308	1330	1354	1343	1340	1348	1324	1313	1313	1284	1265	1257	1215	1175	1128	1023	866
0.7	0.8	0.9	0.9	0.9	0.8	0.8	0.7	0.7	0.0	-0.7	-0.9	-0.2	0.7	1.4	1.2	0.4
0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.7	0.2	-0.6	-1.0	-0.4	0.5	1.3	1.3	0.7
1290	1312	1337	1327	1324	1330	1306	1294	1294	1265	1247	1239	1199	1160	1113	1009	853
0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-0.7	-1.7	-2.1	-1.3	-0.1	1.1	1.2	0.4
0.2	0.2	0.3	0.2	0.2	0.3	0.3	0.3	0.0	-0.6	-1.3	-1.6	-1.1	-0.2	0.7	0.7	0.3
1268	1302	0	1325	1321	0	1298	1285	0	1257	1239	0	1196	1157	0	1002	840
0.2	0.1	0.0	0.0	0.0	0.0	0.2	0.2	0.0	-0.9	-2.1	0.0	-1.8	-0.3	0.0	1.1	0.2
0.1	0.1	0.0	0.1	0.1	0.0	0.2	0.2	0.0	-1.0	-1.6	0.0	-1.4	-0.3	0.0	0.4	0.1
1235	1259	1296	1305	1291	1285	1257	1243	1243	1215	1199	1196	1168	1140	1079	969	819
0.4	0.2	0.2	0.2	0.3	0.3	0.4	0.6	0.7	-0.2	-1.3	-1.8	-1.2	-0.1	0.9	1.1	0.2
0.3	0.2	0.3	0.3	0.3	0.3	0.4	0.5	0.2	-0.4	-1.1	-1.4	-0.9	-0.1	0.6	0.7	0.2
1190	1204	1241	0	1261	1244	1216	1202	1201	1175	1160	1157	1140	0	1035	930	793
0.8	0.7	0.7	0.0	0.7	0.9	1.0	1.2	1.2	0.7	-0.1	-0.3	-0.1	0.0	1.2	1.0	0.1
0.7	0.7	0.7	0.0	0.8	1.0	1.0	1.1	1.1	0.5	-0.2	-0.3	-0.1	0.0	1.1	1.0	0.4
1129	1138	1158	1183	1193	0	1167	1155	0	1128	1113	0	1079	1035	969	884	764
1.0	0.9	0.9	0.8	0.9	0.0	1.2	1.2	0.0	1.4	1.1	0.0	0.9	1.2	1.2	0.7	-0.3
0.9	0.9	0.9	0.9	1.0	0.0	1.2	1.2	0.0	1.3	0.7	0.0	0.6	1.1	1.4	1.2	0.1
1040	1044	1051	1060	1070	1077	1058	1048	1047	1023	1009	1002	969	930	884	824	727
0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.5	1.2	1.2	1.1	1.1	1.0	0.7	-0.2	-1.1
0.5	0.4	0.5	0.5	0.5	0.6	0.7	0.7	1.1	1.3	0.7	0.4	0.7	1.0	1.2	0.2	-1.2
897	897	899	902	904	903	895	887	878	866	853	840	819	793	764	727	674
-0.5	-0.4	-0.3	-0.3	-0.2	-0.2	-0.1	0.0	-0.1	0.4	0.4	0.2	0.2	0.1	-0.3	-1.1	-1.8
-0.5	-0.4	-0.3	-0.3	-0.2	-0.2	-0.1	0.0	0.4	0.7	0.3	0.1	0.2	0.4	0.1	-1.2	-2.8

Assembly power (het.) : 0.31751

Assembly power (1 n/ass.) : 0.32641

Assembly power (4 n/ass.) : 0.31905

Errors (1 n/ass.) Method 1: Av. 3.7% Max. 8.6% Method 2: Av. 3.4% Max. 9.9%

Errors (4 n/ass.) Method 1: Av. 0.7% Max. -2.1% Method 2: Av. 0.7% Max. -2.8%

Table 4.5.2
C5, PX assembly.

1517	1506	1501	1504	1508	1507	1493	1479	1465	1444	1423	1402	1368	1328	1292	1269	1289
6.4	5.3	4.4	4.1	4.4	4.7	4.9	5.3	5.7	3.6	2.6	2.3	1.9	2.0	2.9	5.1	6.2
6.3	5.6	5.1	4.9	5.0	4.9	4.4	3.8	3.0	2.1	4.4	5.7	3.8	0.1	-1.6	2.9	11.3
1238	1434	1422	1432	1459	1489	1436	1419	1440	1386	1367	1385	1325	1272	1244	1267	1179
-2.5	-4.5	-4.7	-4.6	-4.5	-3.9	-4.2	-3.6	-3.2	-6.2	-6.3	-6.0	-6.5	-7.1	-6.2	-2.9	2.7
-2.7	-4.2	-4.1	-3.8	-3.7	-3.6	-4.5	-4.9	-6.8	-6.4	-3.0	-1.1	-3.2	-7.0	-9.6	-7.7	1.9
1105	1272	1285	1334	1353	0	1284	1264	0	1235	1221	0	1229	1189	1137	1159	1121
-4.3	-5.3	-5.1	-5.1	-5.5	0.0	-5.9	-6.0	0.0	-7.4	-5.3	0.0	-5.0	-7.0	-8.0	-5.8	1.7
-4.4	-5.3	-5.0	-4.9	-5.3	0.0	-6.0	-6.3	0.0	-5.9	-2.5	0.0	-2.6	-6.0	-9.1	-9.4	-2.6
1038	1201	1254	0	1249	1365	1274	1251	1279	1221	1211	1266	1133	0	1116	1111	1082
-1.1	-1.0	-0.8	0.0	-1.4	-2.3	-2.7	-3.4	-5.0	-2.6	1.7	3.8	2.2	0.0	-5.8	-5.3	2.7
-1.1	-1.2	-1.1	0.0	-1.7	-2.4	-2.5	-2.7	-3.5	-0.8	2.5	4.1	2.3	0.0	-5.1	-5.8	-0.4
995	1170	1213	1194	1283	1250	1171	1151	1178	1122	1112	1158	1163	1064	1081	1087	1048
3.1	4.2	4.7	4.3	4.5	4.2	3.0	2.0	0.4	4.6	10.2	13.3	10.5	3.6	-2.2	-3.4	3.9
3.2	3.9	4.1	3.5	3.7	3.8	3.4	3.0	2.9	5.5	8.7	10.5	8.3	3.5	-0.1	-0.9	3.8
956	1152	0	1250	1203	0	1147	1129	0	1101	1088	0	1091	1113	0	1070	1009
5.1	6.5	0.0	7.3	7.0	0.0	5.6	4.5	0.0	8.1	14.4	0.0	13.9	6.8	0.0	-3.0	4.1
5.3	6.2	0.0	6.4	6.3	0.0	5.9	5.5	0.0	8.1	11.4	0.0	10.5	6.4	0.0	1.5	6.1
910	1065	1063	1122	1084	1105	1048	1034	1061	1008	995	1023	981	998	945	989	961
3.4	4.1	4.2	4.5	4.4	4.2	3.6	2.9	1.8	6.3	11.5	13.8	10.6	4.2	-2.5	-4.4	2.5
3.5	3.9	3.8	4.1	4.1	3.9	3.7	3.4	3.1	5.6	8.5	10.0	8.0	4.3	0.4	-0.3	4.6
865	1008	1002	1056	1021	1041	991	979	1003	954	940	963	923	937	889	935	912
-0.7	-0.7	-0.7	-0.8	-0.7	-0.6	-0.7	-0.8	-1.6	1.5	5.1	6.4	3.7	-1.1	-5.4	-5.8	0.7
-0.7	-0.7	-0.7	-0.7	-0.6	-0.6	-0.7	-0.9	-1.5	0.6	3.4	4.7	3.0	-0.3	-3.5	-4.3	1.2
821	983	0	1034	1003	0	975	963	0	938	924	0	905	916	0	908	863
-3.4	-4.4	0.0	-4.9	-4.8	0.0	-4.4	-4.3	0.0	-3.7	-2.0	0.0	-3.0	-5.4	0.0	-4.6	0.9
-3.5	-4.4	0.0	-4.7	-4.5	0.0	-4.4	-4.6	0.0	-3.6	-1.0	0.0	-1.2	-4.4	0.0	-7.0	-1.0
772	902	898	944	913	933	886	875	898	852	839	861	823	835	793	832	810
-0.9	-1.4	-1.7	-1.6	-1.5	-1.5	-1.1	-1.2	-2.3	-0.8	1.4	2.0	0.5	-2.4	-4.6	-3.9	1.2
-0.9	-1.2	-1.5	-1.4	-1.2	-1.5	-1.4	-1.6	-2.4	-0.9	1.2	2.0	0.8	-1.8	-4.2	-4.1	0.5
724	845	841	888	858	873	830	818	837	797	785	804	772	784	741	778	757
2.8	3.4	3.6	3.8	3.7	4.1	3.6	3.3	2.5	3.7	6.4	7.9	5.9	2.6	-0.5	-1.1	2.9
3.0	3.5	3.7	3.8	3.7	3.9	3.4	3.2	2.6	3.4	5.5	6.7	5.1	2.6	0.3	0.1	3.9
678	816	0	880	847	0	809	796	0	775	764	0	761	775	0	748	707
4.2	5.2	0.0	6.0	5.9	0.0	5.4	4.9	0.0	5.4	8.6	0.0	8.5	5.0	0.0	-0.2	3.2
4.4	5.3	0.0	6.0	5.8	0.0	5.2	4.9	0.0	5.0	7.2	0.0	7.0	4.5	0.0	2.0	5.4
629	741	767	748	804	786	735	722	739	702	694	722	720	657	673	679	655
1.8	2.2	2.4	2.9	3.1	2.8	2.6	2.1	0.9	2.7	5.5	7.2	6.1	2.5	-1.2	-2.2	1.5
2.0	2.2	2.4	2.8	2.9	2.7	2.5	2.2	1.5	2.5	4.4	5.4	4.6	2.1	-0.3	-0.4	3.0
586	680	708	0	699	760	709	695	708	675	669	697	625	0	620	621	608
-2.6	-3.2	-3.0	0.0	-2.6	-2.8	-2.8	-3.0	-3.8	-2.5	-0.2	1.1	0.0	0.0	-5.2	-5.4	-1.1
-2.6	-3.1	-3.0	0.0	-2.7	-2.9	-2.8	-2.9	-3.4	-2.2	-0.5	0.3	-0.5	0.0	-4.5	-4.6	-1.5
570	657	664	689	695	0	653	641	0	624	615	0	621	603	579	596	584
-6.2	-7.5	-7.5	-7.6	-7.6	0.0	-7.1	-7.1	0.0	-7.0	-5.3	0.0	-5.5	-7.1	-8.0	-7.4	-2.9
-6.3	-7.6	-7.5	-7.6	-7.5	0.0	-7.0	-7.0	0.0	-6.3	-4.7	0.0	-5.0	-6.7	-7.9	-8.0	-4.8
620	723	716	719	730	743	714	704	712	683	673	680	651	626	618	642	611
-5.6	-7.6	-7.5	-7.3	-7.2	-7.2	-7.2	-7.2	-6.9	-7.0	-6.3	-5.8	-6.2	-6.9	-7.0	-5.7	-1.6
-5.8	-7.7	-7.5	-7.3	-7.1	-7.0	-7.0	-7.1	-7.6	-6.7	-5.0	-4.1	-5.0	-6.5	-7.9	-7.6	-3.0
831	823	818	816	814	810	801	791	781	767	754	740	723	705	694	703	757
-0.2	-0.3	-0.3	0.0	0.3	0.3	-0.1	-0.2	0.2	0.2	0.3	0.5	0.1	0.0	0.5	1.9	3.0
-0.3	-0.4	-0.5	-0.2	0.2	0.5	0.3	0.1	-0.4	0.1	1.7	2.7	1.6	-0.6	-1.8	-0.1	3.6

Assembly power (het.) : 0.25399

Assembly power (1 n/ass.) : 0.24965

Assembly power (4 n/ass.) : 0.25391

Errors (1 n/ass.) Method 1: Av. 11.3% Max. 34.8% Method 2: Av. 10.1% Max.-24.8%

Errors (4 n/ass.) Method 1: Av. 4.0% Max. 14.4% Method 2: Av. 3.9% Max. 11.4%

Table 4.5.3
C5, UX assembly, lower right.

627	634	625	611	593	571	545	517	489	459	429	400	370	344	327	330	377
-9.2	-6.6	-1.9	2.1	4.5	5.0	3.5	1.2	-1.9	-0.2	1.4	1.7	0.5	-1.9	-4.2	-5.4	-6.6
-6.8	-1.4	2.1	2.1	0.9	0.0	0.0	0.5	-0.2	0.2	0.9	0.7	-0.2	-1.7	-3.3	-4.7	-7.3
634	676	684	677	665	647	611	580	553	515	481	453	416	383	362	361	399
-6.6	-3.3	1.2	4.5	5.7	5.7	5.0	3.1	-0.2	1.2	2.8	2.8	1.4	-0.7	-3.1	-4.7	-6.4
-1.4	2.8	4.7	3.8	1.4	0.0	0.5	1.7	1.9	1.4	2.1	1.7	0.5	-0.9	-2.4	-3.8	-5.9
625	684	707	714	702	0	641	607	0	539	503	0	440	405	377	369	401
-1.9	1.2	3.5	3.5	2.6	0.0	1.7	1.9	0.0	1.4	2.6	0.0	0.9	-0.5	-2.4	-3.3	-4.5
2.1	4.7	5.2	3.1	0.5	0.0	-1.2	0.7	0.0	1.4	2.4	0.0	0.7	-0.7	-2.1	-2.6	-3.8
611	677	714	0	703	672	632	598	570	531	496	469	439	0	381	367	394
2.1	4.5	3.5	0.0	-3.1	-4.7	-3.8	-1.2	0.5	0.5	0.9	0.7	-0.2	0.0	-2.4	-2.4	-2.8
2.1	3.8	3.1	0.0	-2.4	-4.0	-3.5	-1.7	-0.2	0.5	1.2	1.2	0.0	0.0	-2.6	-2.8	-3.1
593	665	702	703	680	655	616	583	556	517	483	456	424	398	374	360	381
4.5	5.7	2.6	-3.1	-8.0	-10.4	-8.7	-4.5	-0.7	-0.9	-0.7	-0.9	-1.9	-2.6	-2.8	-2.4	-1.9
0.9	1.4	0.5	-2.4	-5.2	-6.6	-6.1	-4.0	-2.1	-0.9	0.0	0.0	-0.9	-2.4	-3.1	-3.3	-2.8
571	647	0	672	655	0	599	567	0	503	469	0	408	380	0	348	365
5.0	5.7	0.0	-4.7	-10.4	0.0	-11.3	-6.6	0.0	-1.9	-1.7	0.0	-2.6	-3.1	0.0	-2.1	-1.9
0.0	0.0	0.0	-4.0	-6.6	0.0	-7.3	-5.4	0.0	-2.1	-0.9	0.0	-1.9	-2.8	0.0	-3.1	-2.8
545	611	641	632	616	599	566	536	511	474	443	416	383	356	339	328	346
3.5	5.0	1.7	-3.8	-8.7	-11.3	-10.1	-6.1	-2.1	-1.7	-1.4	-1.4	-1.9	-2.4	-2.6	-2.4	-2.4
0.0	0.5	-1.2	-3.5	-6.1	-7.3	-6.8	-5.0	-3.1	-1.7	-1.2	-0.9	-1.7	-2.6	-3.1	-2.8	-2.1
517	580	607	598	583	567	536	508	483	449	419	393	361	335	319	309	326
1.2	3.1	1.9	-1.2	-4.5	-6.6	-6.1	-4.0	-1.7	-0.9	-0.2	0.0	-0.5	-1.2	-1.7	-1.9	-2.4
0.5	1.7	0.7	-1.7	-4.0	-5.4	-5.0	-3.1	-1.7	-0.9	-0.2	0.0	-0.7	-1.4	-2.1	-1.9	-1.4
489	553	0	570	556	0	511	483	0	428	398	0	343	318	0	293	307
-1.9	-0.2	0.0	0.5	-0.7	0.0	-2.1	-1.7	0.0	-0.7	0.5	0.0	0.0	-0.7	0.0	-1.7	-2.1
-0.2	1.9	0.0	-0.2	-2.1	0.0	-3.1	-1.7	0.0	-0.5	0.5	0.0	-0.2	-0.9	0.0	-1.9	-1.9
459	515	539	531	517	503	474	449	428	397	369	347	318	295	281	271	286
-0.2	1.2	1.4	0.5	-0.9	-1.9	-1.7	-0.9	-0.7	-0.7	0.0	0.0	-0.2	-0.7	-1.2	-0.7	-0.2
0.2	1.4	1.4	0.5	-0.9	-2.1	-1.7	-0.9	-0.5	0.2	0.9	0.7	0.2	-0.7	-1.7	-1.9	-2.1
429	481	503	496	483	469	443	419	398	369	344	323	296	275	261	252	265
1.4	2.8	2.6	0.9	-0.7	-1.7	-1.4	-0.2	0.5	0.0	0.2	0.2	0.2	-0.2	-0.5	-0.2	0.5
0.9	2.1	2.4	1.2	0.0	-0.9	-1.2	-0.2	0.5	0.9	1.2	1.2	0.7	-0.2	-0.9	-1.2	-1.7
400	453	0	469	456	0	416	393	0	347	323	0	279	259	0	236	245
1.7	2.8	0.0	0.7	-0.9	0.0	-1.4	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.0	-0.2	0.2
0.7	1.7	0.0	1.2	0.0	0.0	-0.9	0.0	0.0	0.7	1.2	0.0	0.7	0.0	0.0	-1.2	-1.2
370	416	440	439	424	408	383	361	343	318	296	279	258	241	226	215	225
0.5	1.4	0.9	-0.2	-1.9	-2.6	-1.9	-0.5	0.0	-0.2	0.2	0.2	0.2	-0.2	-0.7	-0.7	-0.5
-0.2	0.5	0.7	0.0	-0.9	-1.9	-1.7	-0.7	-0.2	0.2	0.7	0.7	0.2	-0.2	-0.9	-1.2	-1.2
344	383	405	0	398	380	356	335	318	295	275	259	241	0	207	196	206
-1.9	-0.7	-0.5	0.0	-2.6	-3.1	-2.4	-1.2	-0.7	-0.7	-0.2	0.0	-0.2	0.0	-1.4	-1.2	-1.4
-1.7	-0.9	-0.7	0.0	-2.4	-2.8	-2.6	-1.4	-0.9	-0.7	-0.2	0.0	-0.2	0.0	-1.4	-1.2	-1.2
327	362	377	381	374	0	339	319	0	281	261	0	226	207	190	181	189
-4.2	-3.1	-2.4	-2.4	-2.8	0.0	-2.6	-1.7	0.0	-1.2	-0.5	0.0	-0.7	-1.4	-1.7	-1.7	-1.7
-3.3	-2.4	-2.1	-2.6	-3.1	0.0	-3.1	-2.1	0.0	-1.7	-0.9	0.0	-0.9	-1.4	-1.7	-1.2	-0.5
330	361	369	367	360	348	328	309	293	271	252	236	215	196	181	173	179
-5.4	-4.7	-3.3	-2.4	-2.4	-2.1	-2.4	-1.9	-1.7	-0.7	-0.2	-0.2	-0.7	-1.2	-1.7	-1.7	-1.4
-4.7	-3.8	-2.6	-2.8	-3.3	-3.1	-2.8	-1.9	-1.9	-1.9	-1.2	-1.2	-1.2	-1.2	-1.2	-0.5	0.5
377	399	401	394	381	365	346	326	307	286	265	245	225	206	189	179	179
-6.6	-6.4	-4.5	-2.8	-1.9	-1.9	-2.4	-2.4	-2.1	-0.2	0.5	0.2	-0.5	-1.4	-1.7	-1.4	-0.9
-7.3	-5.9	-3.8	-3.1	-2.8	-2.8	-2.1	-1.4	-1.9	-2.1	-1.7	-1.2	-1.2	-1.2	-0.5	0.5	1.7

Assembly power (het.) : 0.11198

Assembly power (1 n/ass.) : 0.10961

Assembly power (4 n/ass.) : 0.11075

Errors (1 n/ass.) Method 1: Av. 10.6% Max.-33.2% Method 2: Av. 8.8% Max. 27.6%

Errors (4 n/ass.) Method 1: Av. 2.2% Max.-11.3% Method 2: Av. 1.9% Max. -7.3%

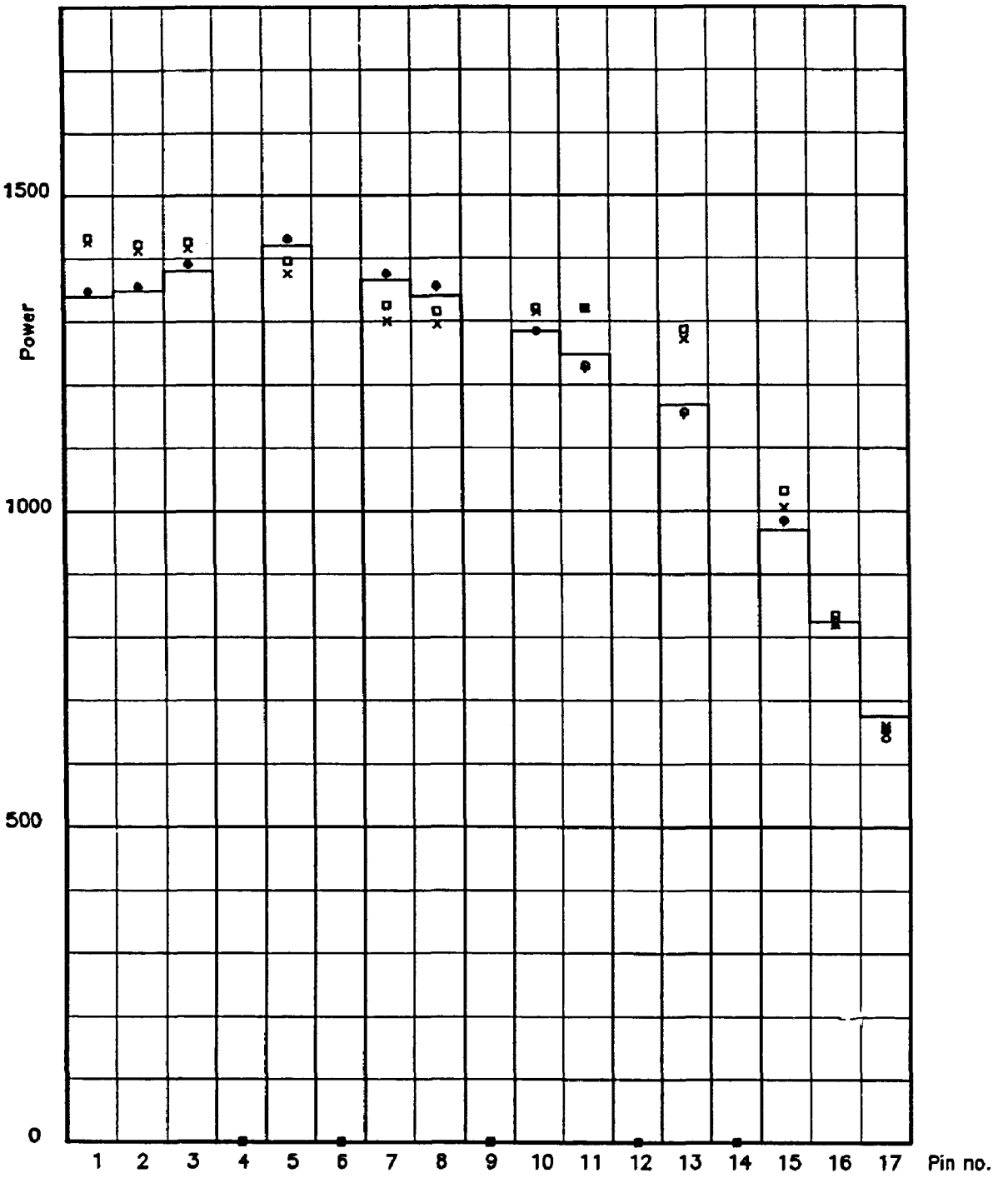


Figure 4.5.1

C5, UX ASSEMBLY

Diagonal power traverse

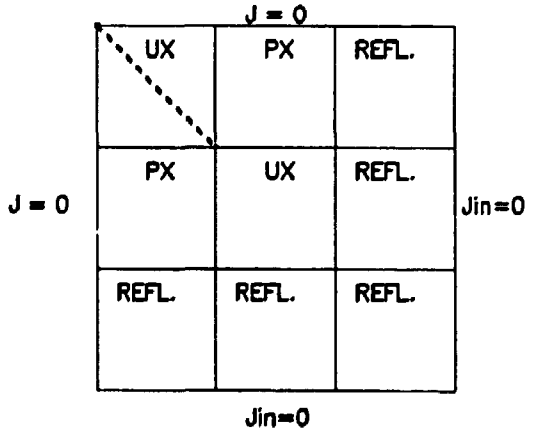
—— 'Heterogeneous' calc.

× Method 1, 1 node /ass.

\+ Method 1, 4 nodes/ass.

□ Method 2, 1 node /ass.

o Method 2, 4 nodes/ass.



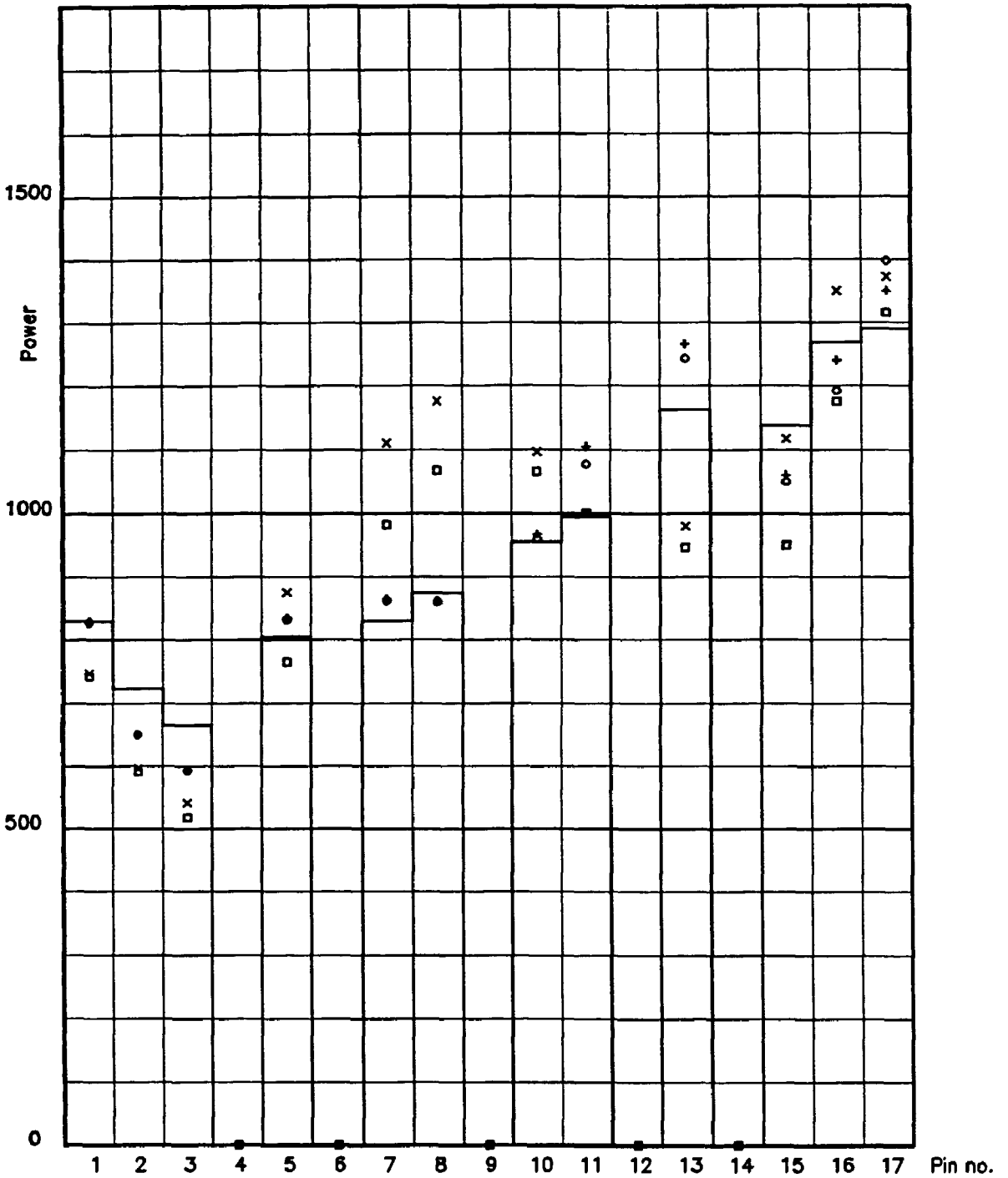
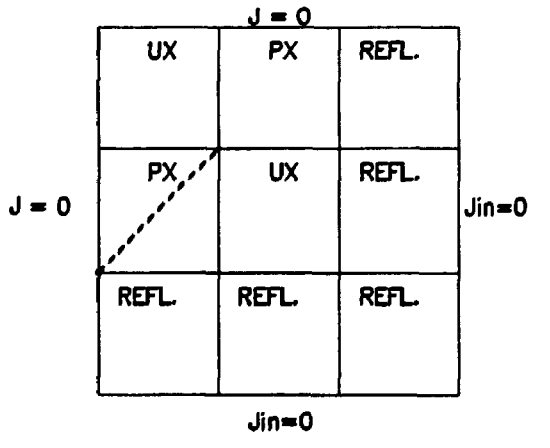


Figure 4.5.2

C5, PX assembly

Diagonal power traverse

- ——— 'Heterogeneous' calc.
- × Method 1, 1 node /ass.
- \+ Method 1, 4 nodes/ass.
- □ Method 2, 1 node /ass.
- ○ Method 2, 4 nodes/ass.



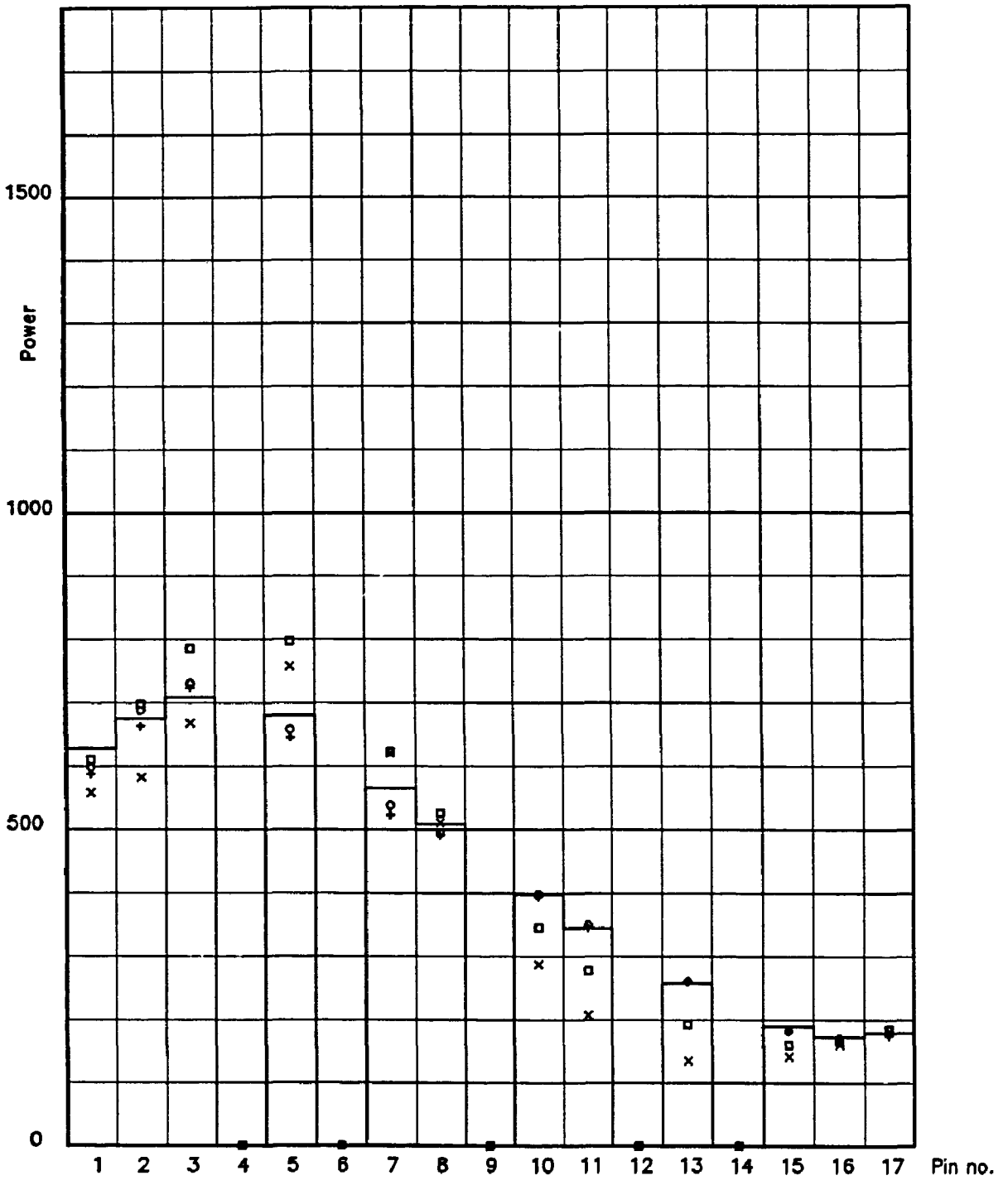


Figure 4.5.3

C5, UX ASSEMBLY

Diagonal power traverse

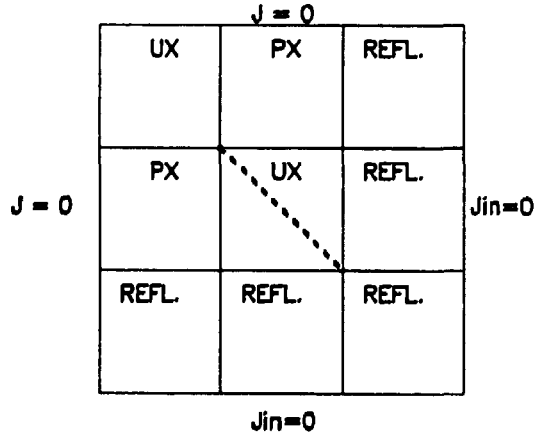
——— 'Heterogeneous' calc.

× Method 1, 1 node /ass.

\+ Method 1, 4 nodes/ass.

□ Method 2, 1 node /ass.

o Method 2, 4 nodes/ass.



5 Conclusions

The power distributions calculated with the NEM2D code with 1 node/pin cell are very close to what is considered the »best« values of the benchmark contributors. So far, the only release of these results is in (5).

The k_{eff} and assembly powers calculated with »practical« methods are satisfactorily close to the »reference« values.

The pin power reconstructions using quarter assemblies are satisfactory with both of the applied methods, while reconstructions based on whole-assembly calculations are very inaccurate in some cases. Again, this holds for both methods.

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Abstract (Max. 2000 characters)

This report describes calculations performed for the NEACRP pin-power benchmark. The calculations are made with the code NEM2D, a diffusion theory code based on the nodal expansion method.

Descriptors INIS/EDB

BENCHMARKS; COMPUTER CALCULATIONS; FUEL ASSEMBLIES; FUEL PINS; N CODES; NEUTRON FLUX; NODAL EXPANSION METHOD; POWER DISTRIBUTION; PWR REACTOR TYPE; REACTOR PHYSICS; TWO-DIMENSIONAL CALCULATIONS

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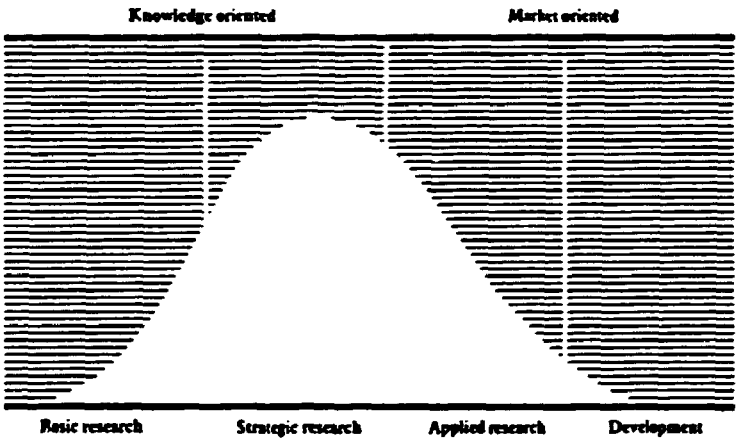

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